New Metaphors

A Workshop Method for Generating Ideas and Reframing Problems in Design and Beyond

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ABSTRACT

Metaphors are important at multiple levels within design and society—from the specifics of interfaces, to wider societal imaginaries of technology and progress. Exploring alternative metaphors can be generative in creative processes, and for reframing problems strategically. In this pictorial we introduce an inspiration card workshop method using juxtaposition (or *bisociation*) to enable participants to explore novel metaphors for hard-to-visualise phenomena, drawing on a provisional set of inspiration material. We demonstrate the process through illustrating creative workshops in France, Portugal, Chile, and the USA, and reflect on benefits, limitations, and potential development of this format for use within interaction design.

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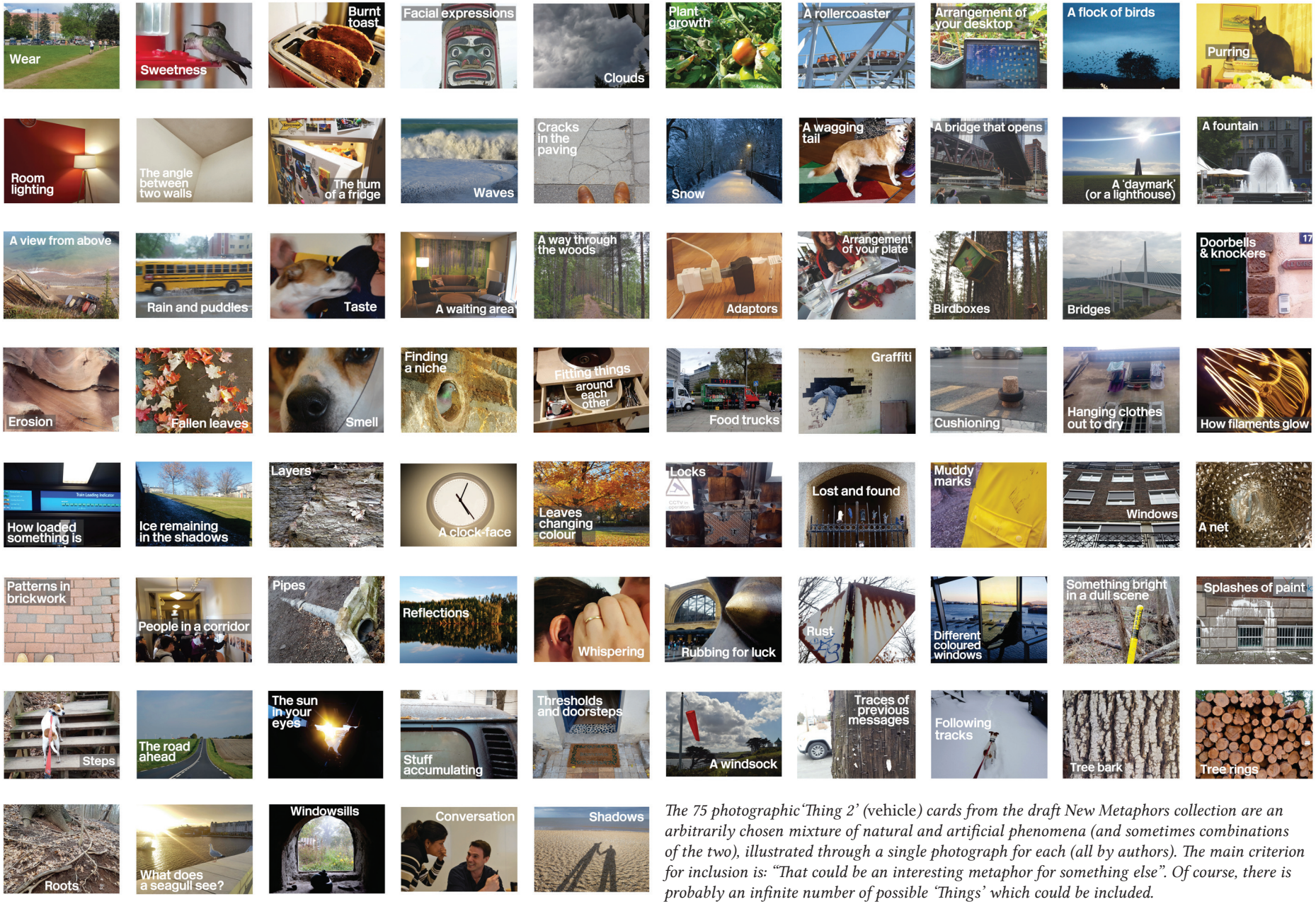
A metaphor is:

> **"a device for seeing something in terms of something else. It brings out the thisness of that or the thatness of a this."**
>
> Kenneth Burke, 1945 [14]

Below: How could BURNT TOAST *be a metaphor for* CLIMATE CHANGE*? Could* CRACKS IN THE PAVING *be a metaphor for* UNWRITTEN RULES*, or a* NET *a metaphor for* ANXIETY*?*



The 75 photographic 'Thing 2' (vehicle) *cards from the draft New Metaphors collection are an arbitrarily chosen mixture of natural and artificial phenomena (and sometimes combinations of the two), illustrated through a single photograph for each (all by authors). The main criterion for inclusion is: "That could be an interesting metaphor for something else". Of course, there is probably an infinite number of possible 'Things' which could be included.*

Origin of the electricity you're using	The back-story of a product	The presence of AI or an algorithmic decision-maker	Experience that comes with age (rather than age itself)	A headache	Overwhelmed-ness	That crisp autumn/ fall feeling	Who occupied this exact place before you did?	TripAdvisor comments	Confidence
Contentedness	Laws or standards	Neighbourliness	Driver alertness	People's accents	Personal data security	Fame	Other people's thoughts, emotions, or opinions	Social relations between people	Corruption in government or business
Mess	Self-care	Butterflies in your stomach	Sense of duty	How to tell yourself that you're doing OK	Worrying about what people think of you	The balance of flavours in a meal	Gene therapy	The feeling of coffee with a friend	Doing your tax return
Insurance	Anxiety	Trust in another person	Trust in a brand or product	Online discussion	What it's like to live in a particular city	A culture	Being a parent	Being a refugee	Unwritten rules
Whether a way of doing something is seen as modern or old-fashioned	How clean water is	Your diet	The country's economy	Encrypted messaging	Two-factor security	Confusion	Half-remembered dreams	Social or peer pressure	History of an idea
What is it that motivates me?	Sunday afternoon feeling	Friday night feeling	WiFi signals	Viruses, bacteria, or diseases	Complexity	Protection	Hype around new technology	How innovations diffuse into society	Pensions
Employment rights	Soli fertility for growing crops	Blockchain	Climate change	Migration	Safety	Love	Attraction	Feeling proud of someone	Whether someone's clothes suit them
Finding it difficult to make a decision	Warmth (physical or emotional)	Power relations between people	Your emotions	Exercise or movement					

The 75 textual 'Thing 1' (tenor) *cards each represent "an abstract concept which is difficult to visualise, but which might be possible to do through using a metaphor". They are drawn from the authors' own noticings, and from concepts which have been suggested by students and workshop participants. The Thing 1 cards are optional (and potentially unnecessary) in the workshop format, if participants come with a 'Thing 1' for which they seek a metaphor.*

METAPHORS OLD AND NEW

Much—perhaps all—interaction design employs metaphors, initially to introduce new approaches to interaction, structure, and display [4, 9]—"a one-way semantic link between a familiar physical object and a new digital system'' [34], but over time becoming so familiar that they perhaps are reified [9], no longer thought of as 'metaphors' any more [26]. Do we even notice the metaphorical component of desktops and windows and folders and files? What about blockchain, the cloud, feeds, threads, forums, "data is the new oil" [58], the net, browsers, the web, websites, or the notion of a 'site' itself? Interfaces, displays, and the structures of products and services themselves are often reliant on a relatively small set of metaphors; there are many phenomena where new metaphors could potentially enable new forms of understanding, sharing or changing mental models [54], or experiencing otherwise invisible processes in more interesting ways.

Novel or alternative metaphors are sometimes intentionally sought in design [55, 9], for example where a new product or technology offers new affordances which require some 'anchoring' (itself a metaphor) to a familiar concept [17, 34], as a problem-solving aid [15], or where problems or limitations have been identified with an existing metaphor which suggest the need for alternatives.

Reviewing HCI and design literature over the past decade gives examples including: a magic 'barrier tape' in virtual reality [18], shadows and sinking/floating in augmented reality [42], sunflowers for visualising data as an alternative form of scatterplot [40], haunting as a metaphor for multisensory displays and objects in a living room [2], exploration of the notion of hybrids [21], new kinds of file formats for shared working [30, 41], pregnancy as a metaphor for new packaging design [16], robots and artificial intelligence as sidekicks rather than servants [12, 48], and alternative metaphors for networked products and services drawing on anxieties as inspiration [52].

Many challenges facing humanity today and in the future are complex, involving relationships, systemic intricacies, and timescales which are difficult to understand and represent in simple terms. As such, humans simplify; and those simplifications can have consequences which impede attempts to tackle problems. For example, the multiple feedback loops, scale and duration, uncertainty and non-linearity of climate change may be reduced by popular media discourse to 'global warming', a framing whose 'validity' (along with trust in science itself) is held open to question. Often, complex issues are rendered understandable through the use of metaphors and analogies, and indeed it has been argued that these are central to human reasoning, understanding, and creativity [10, 32], as well as the linguistic aspects of cognition itself [38]. (Here we use the term 'metaphor' in a broad, imprecise way, to refer to a variety of ways in which one thing can be understood in terms of another). One simple reason for metaphors' prevalence is that by mapping features of an existing or familiar situation onto a new or unknown one, we are enabled to grasp it more quickly. Nevertheless, metaphors are not the thing itself—they are always an abstraction, a model of the situation (and in being brought into being, they become a third thing [9]). They can be a map to a territory, but should not be mistaken for the territory. All metaphors are wrong, but some are useful; they can become "enabling constraints" [31] or a kind of disruptive improvisation [1, 46].

Metaphors beyond design and HCI

Artists and poets may be experts in creating new metaphors, but as well as within design practice, the intentional construction of metaphors to enable new ways of thinking has been proposed by people in many fields, ranging from anthropology (e.g. Margaret Mead and Mary Catherine Bateson [5]) to politics (e.g. George Lakoff [37]). In economics, studies have noted how the metaphor of 'the national economy as a household budget', or even 'a container/bucket/pot' commonly employed by media and politicians, is a structural error in terms of many key features of the systems, such as fixation on 'balancing the books' or people in need being 'a drain on the system'. This leads to specific policy decisions being made that arguably cause harm. How would political discourse on the economy be different if a different metaphor were used? We can imagine ideas such as THE ECONOMY IS A GARDEN or THE ECONOMY IS A LOAF OF BREAD BEING BAKED; the New Economics Foundation and partners [50] tested new metaphors such as THE ECONOMY IS A COMPUTER THAT CAN BE REPROGRAMMED through surveys with the British public. (Indeed, the authors of this pictorial hosted a webinar for the Disruptive Innovation Festival 2018, run by circular economy charity the Ellen MacArthur Foundation, in which new metaphors were generated and discussed relating to circular economy issues, including ORGAN DONATION as a metaphor for CIRCULAR BUSINESS MODELS, and LEAVES CHANGING COLOUR as a metaphor for PRODUCT END-OF-LIFE.)

From global issues to local ones (e.g. engagement with local government), right down to the personal level (e.g. mental health [49]), there is an opportunity for new metaphors to be generated, and adopted and adapted from other cultures, traditions, and contexts, and their effects on people's understanding of issues investigated. As Schön [55] argued for the examination of generative metaphor in problem-setting in social policy, exploring the metaphors in use can condition the ways that problems are approached, and generating different metaphors can enable new perspectives.

We suggest that generating new metaphors could inspire creative approaches to designing novel interfaces, products, services, communication campaigns, ways of explaining ideas, and more widely, reframing of societal issues around technology and other issues of global importance, providing an expanded 'conceptual vocabulary' [43], and that a method for doing so could be a useful part of the designer's toolbox.

Generating metaphors

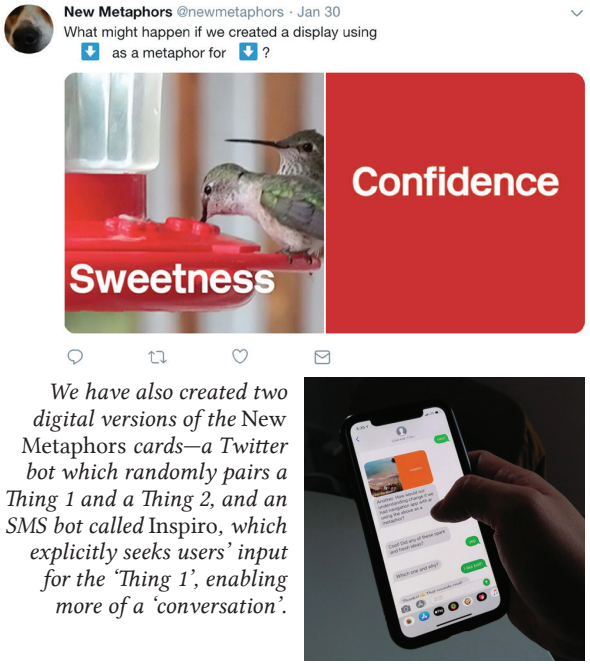
The hunt for "defensible metaphors", to use cybernetician Gordon Pask's term [56], is not trivial, and while the role of 'metaphor designer' is emerging [24], there is little in the way of methods or structured approaches to generating relevant new metaphors given a particular issue or domain. There are computational approaches centred on structure-mapping [27], metaphors as "conceptual mappings wherein a concept from a source domain partially structures the understanding of a concept from a target domain" [7], along with systematic generation of *analogies* for suggesting solutions to engineering challenges. Generative creativity [20] is a growing area of current research in computer science, particularly enacted through bots, sometimes random and sometimes based around neural networks, and metaphors have made an appearance, for example with Katy Gero and Lydia Chilton's *Metaphoria* [28] and Darius Kazemi's *Metaphor-A-Minute* [35]. But among 'human' creativity methods

[25] the most notable current metaphor generation work in the HCI community comes from Nick Logler, Daisy Yoo and Batya Friedman, whose *Metaphor Cards* [47] offer a detailed domain-centred process which brings designers into a much deeper, reflective understanding of the field in which they are generating new metaphors, with an example application around international justice.

In contrast, the *New Metaphors* cards and workshop method, described and illustrated in this pictorial, is very simple, perhaps even superficially so. Participants simply browse sets of image and text cards which they combine in creative ways to suggest possible metaphors (optionally going through a characteristic-mapping process), and then they think further about how a concept might be developed based around the new metaphors they have generated. This process of *bisociation*—as described by Arthur Koestler, "the perceiving of a situation or idea… in two self-consistent but habitually incompatible frames of reference" [36]—or simple juxtaposition of ideas as a provocation in the style of Edward de Bono [11] or games such as *Mad Libs* [53] or *Cards Against Humanity* [22] is a common feature of inspiration card workshops [8] and is fast-paced, intended to be a creative trigger method to generate multiple ideas quickly and then enable subsequent evaluation and development. The workshop participants may come with their own specific domain knowledge or a problem or issue for which they seek new metaphors, or they may use the cards to address topics of which they have little knowledge, but which can nevertheless provide a provocation for thinking differently.

The cards and workshop process

We produced two sets of cards, shown on pages 2 and 3 of this paper. **Thing 1** cards, solely textual, feature the names of an assorted selection of phenomena and abstract concepts which may be difficult to visualise, but which might be possible to do through using a metaphor. They are drawn from the authors' own noticings, and from concepts which have been suggested by students, previous workshop participants, and topics in previous projects ranging from energy use [13] to career paths [54]. These ranged from invisible system relationships (e.g. POWER RELATIONS BETWEEN PEOPLE or even WIFI SIGNALS) to intangible emotions, feelings or personality properties (e.g. CONFIDENCE or A HEADACHE). We considered



We have also created two digital versions of the New Metaphors *cards—a Twitter bot which randomly pairs a Thing 1 and a Thing 2, and an SMS bot called* Inspiro*, which explicitly seeks users' input for the 'Thing 1', enabling more of a 'conversation'.*

that each of these phenomena was something we would be interested in seeing (or otherwise experiencing) an interface or display for, or a rethink of how it was explained or presented. The Thing 1 cards—in metaphor terminology, the *tenor*—are 'optional' for the workshop process, in the sense that participants may already have problems or issues for which they seek new metaphors. Some of the workshops we have run have explicitly asked participants to come with domain-specific issues themselves.

Thing 2 cards show a photograph and the name of a phenomenon in the world which could potentially be an interesting metaphor for some of the Thing 1s—an arbitrarily chosen mixture of natural and artificial phenomena (and sometimes combinations of the two). The examples were partly drawn from sensory or synaesthesia-inspired ideas [39], such as SWEETNESS, and partly from everyday phenomena that seemed interesting as potential 'design' material—particularly drawing on work around qualitative interface design [45], indexical visualisation [51] and data physicalisation [33]—from THE HUM OF A FRIDGE to THE ARRANGEMENT OF YOUR DESKTOP. THE ANGLE BETWEEN TWO WALLS, odd as it seems, was a reference to a question once asked by J.G. Ballard, who wrote and spoke extensively on metaphors [3].

In total, 75 Thing 1 and 75 Thing 2 cards were included in the set—giving 5,625 possible combinations of "Thing 2 as a metaphor for Thing 1". (It is worth noting that some of the Thing 1s could also work as metaphors for the Thing 2s). Blank card templates were also included, to prompt users of the cards to suggest their own Thing 1s or Thing 2s. Of course, the 150 cards are provisional: while there can never be a 'complete' set of these, we aim to continue expanding the library and there is the potential for more focused domain-specific subsets. The current set is available as a Creative Commons-licensed download from *http://imaginari.es/new-metaphors*

The next few pages of this pictorial illustrate the four stages of the workshop process, including how participants, in groups, used the cards and worksheets to generate new metaphors and then concepts for new products, services, interfaces, and reframings. (We briefly discuss a few interesting ideas emerging.) The images featured are drawn from *New Metaphors* workshops run with design (mainly interaction and user experience) and futures practitioners, and students, in France (workshops at IxDA Interaction 18, Lyon, and the Plurality University Network's *Portes Ouvertes*, in Paris, both with practitioners), Portugal (workshop at the UX Libson 2018 conference, with practitioners), Chile (workshops at the Universidad del Desarrollo in Santiago and Concepción, both with students), and the USA (workshops at the Google SPAN 2017 conference, with practitioners, and the Swartz Center for Entrepreneurship at Carnegie Mellon University, with students). We have used industry conferences and events as venues for running the workshops, with the aim of getting insights from practitioners who may be a target audience for the method. In total, the workshops illustrated here included around 180 participants, usually working in groups of 4–6 people, and usually with 20–45 minutes to run through the stages. We have, in addition, explored using variants of the workshop method and cards for teaching within conventional classroom and studio settings, and in workshops at academic conferences (e.g. [1]), and in digital versions, although this pictorial concentrates on the seven workshops listed above.

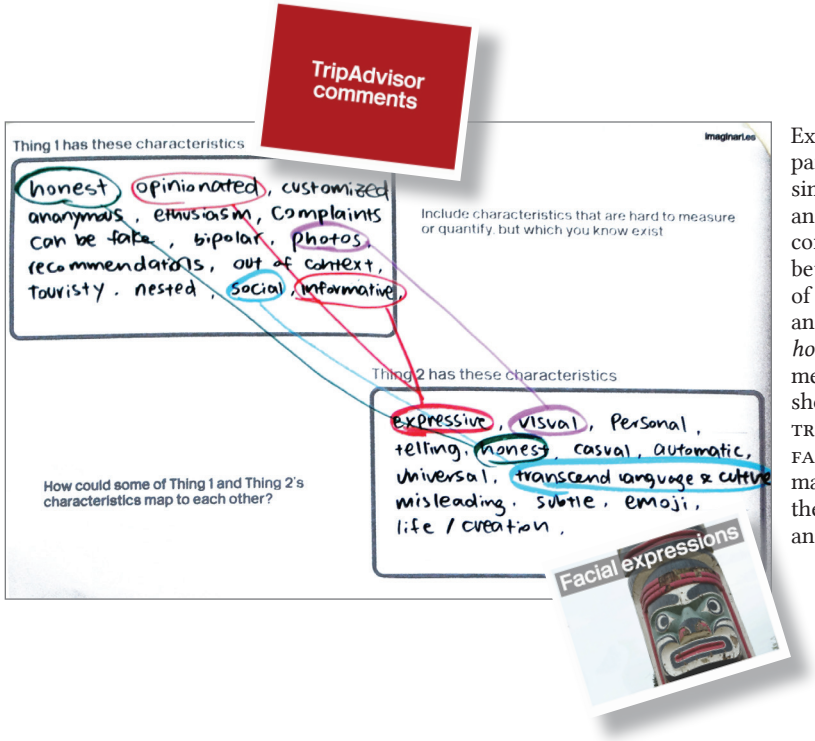
Stage 1 of the workshop (right) involves participants exploring and discussing, in groups, essentially serendipitous juxtapositions of a selection of Thing 1 and Thing 2 cards to see whether any combinations 'fit' in terms of being interesting or appropriate metaphors. If participants already have a 'Thing 1' of their own, then only the Thing 2 cards are used.



In **Stage 2**, participants use worksheets (see next page) to map characteristics of Thing 1 & 2 pairings they find interesting, and identify commonalities that could be developed further.

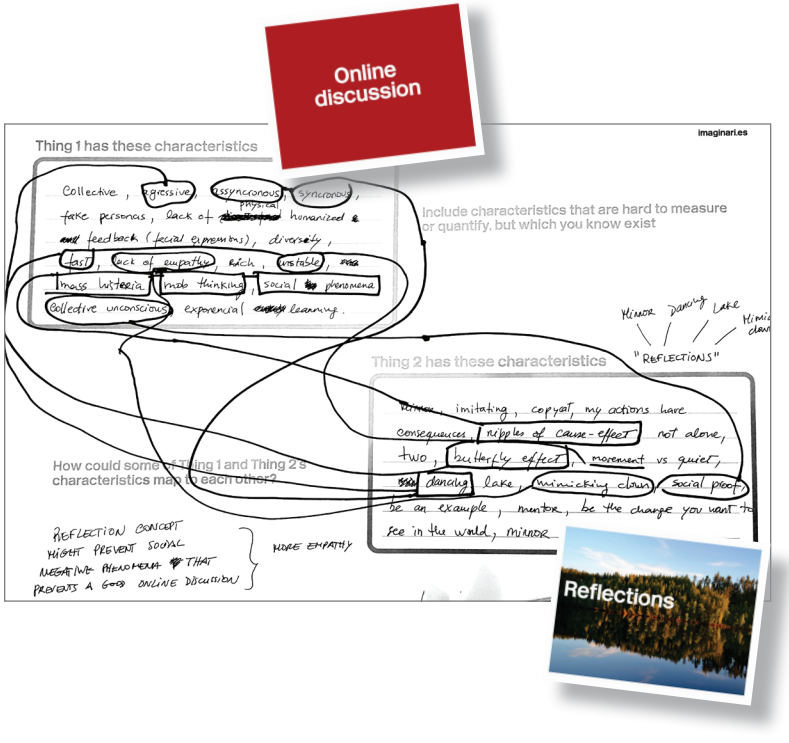

In some versions of the workshop, variants of the worksheet (immediate right two images) or no worksheets at all (furthest right image—labels in Portuguese) are used to explore the mappings.

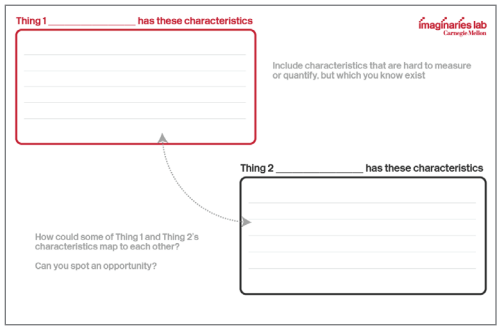


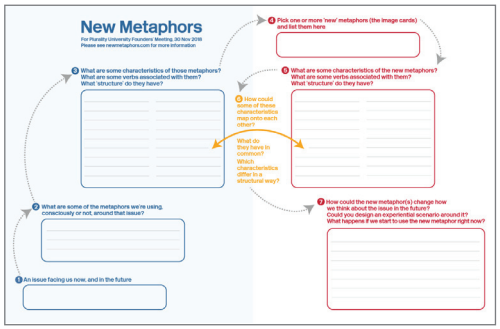


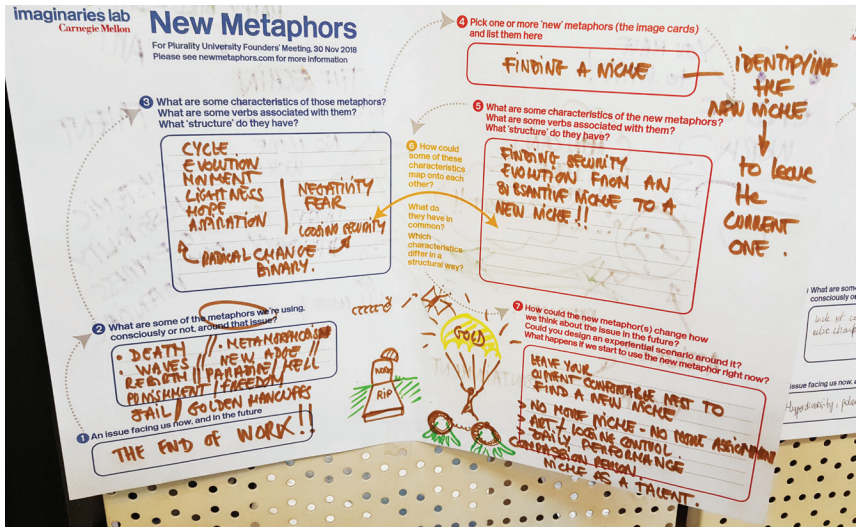
Examples of how participants have used simple worksheets to list, and then find connections, commonalities, or mappings between, characteristics of a particular Thing 1 and Thing 2—essentially, *how* could this work as a metaphor? In the worksheet shown left, characteristics of TRIPADVISOR COMMENTS and FACIAL EXPRESSIONS were mapped; in the example on the right, ONLINE DISCUSSION and REFLECTIONS.

The use of the (Virginia Water) totem pole image to represent facial expressions has been reviewed and the next iteration of the cards uses an alternative facial image.

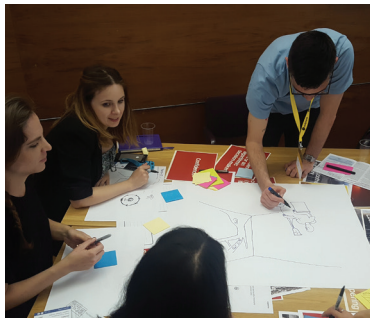








Two variant worksheets for particular participant groups. A version for a business school entrepreneurship class (above left) added the line 'Can you spot an opportunity?' while a more comprehensive redesign (above right, and right) for a meeting of futurists and science fiction writers focused on rethinking existing metaphors around 'An issue facing us now, and in the future', selecting a new metaphor from the Thing 2 cards, and mapping similarities and differences between the two metaphors' characteristics. The example here contrasts existing metaphors for THE END OF WORK (including DEATH, PARADISE, HELL, and FREEDOM) with a new metaphor, FINDING A NICHE.



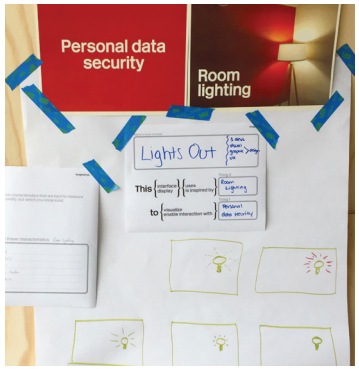


In **Stage 3** (above six images), participants generate ideas for a new interface, product, service, communication campaign, way of explaining an idea, or other development, based around the new metaphor they choose.

They then present them to the group in **Stage 4** (right eight images). Here we see sketches of ideas including: an app for shoppers using PLANT GROWTH as a metaphor for THE BACK-STORY OF A PRODUCT; 'Taxcraft', Minecraft-esque tax software using PATTERNS IN BRICKWORK as a metaphor for DOING YOUR TAX RETURN; a spatial redesign of wireless network strength indication using A FLOCK OF BIRDS as a metaphor for WI-FI SIGNALS; and FINDING A NICHE as a metaphor to help society think more strategically about THE END OF WORK.

'Overgrown' (above) used PLANT GROWTH as a metaphor for OVERWHELMEDNESS. The idea is a possible extension to productivity, task management and to-do list software: an interface representing tasks through a garden in which some tasks grew of their own accord to overwhelm or shade out others (and needed tending to, or weeding out), while others needed careful nurture to grow and bloom or bear fruit.

Some related existing metaphors were also worked into the concept—'thorny' issues, bugs on plants but also as elements which 'bug' you; processes of (at)tending to tasks to prevent them becoming overwhelming.



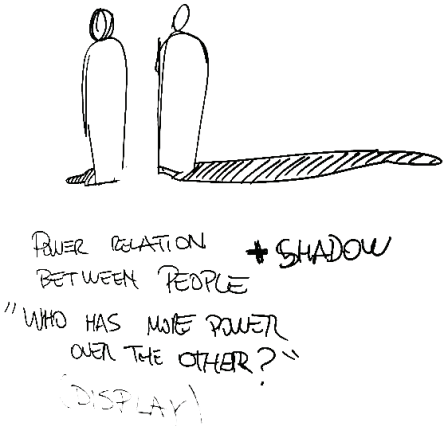
'Lights Out' (left) used of ROOM LIGHTING as a metaphor for PERSONAL DATA SECURITY—ambient lighting would dim if the user were in a situation where there was more risk to their data, indicating the need to be careful (or to take action). Different lighting patterns indicate types of risk.

or

as a metaphor for

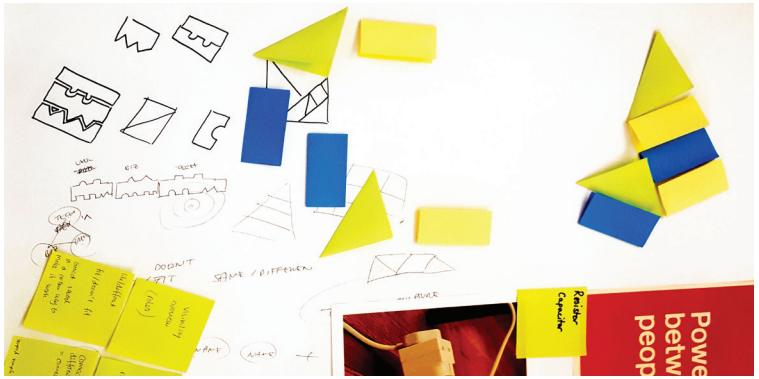
Power relations between people

?



The ways two groups (in different workshops) addressed POWER RELATIONS BETWEEN PEOPLE make an interesting comparison. One group focused on SHADOWS as a metaphor (below left), envisaging an augmented reality display which would enable people within an organisation to 'see' the influence or power that people had over each other, via simulated shadows cast from one person to another.

Another group (below) used ADAPTORS as a metaphor—already 'transforming power' in a different way—but here used as the starting point for exploring a new kind of model for planning a team within an organisation, using adaptable (foldable, reconfigurable) shapes as a kind of construction kit to represent people with different skills, roles, and fit. The idea was to be able to *see* how teams fit together, and how different components (people) transform power in different ways to achieve the end result. Other electrical components such as resistors and capacitors were discussed—how metaphorical is someone with the 'resistor' role?

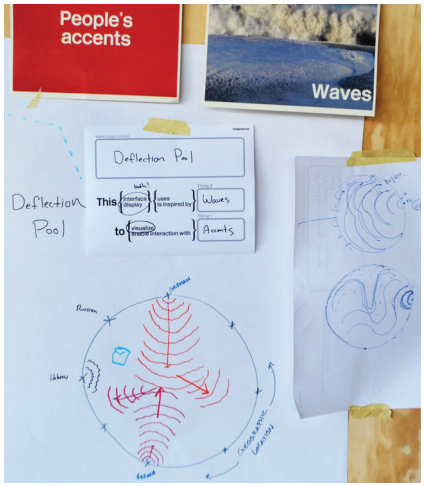


as a metaphor for

The balance of flavours in a meal

and

People's accents

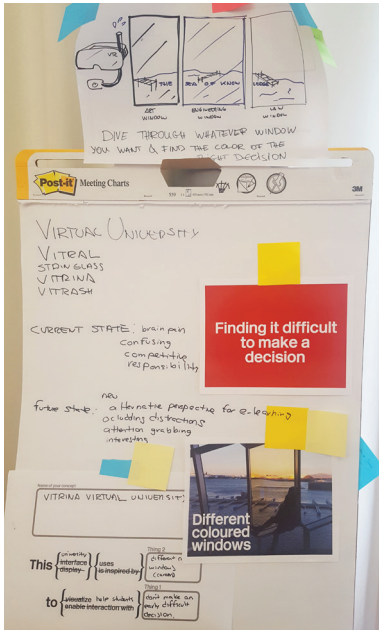


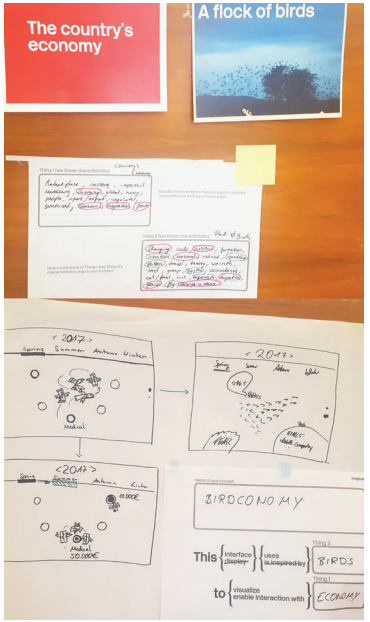
As a contrast, here are two ways in which groups (again, in different workshops) used the same Thing 2 (WAVES) as a metaphor for different Thing 1s—once as a metaphor for THE BALANCE OF FLAVOURS IN A MEAL, and once as a metaphor for PEOPLE'S ACCENTS.

'Tastebuddies' (above left) is a concept for an app which people can use to track and plan experiences of trying new cuisines at restaurants, and match up with potential dining 'buddies' based on a wave-like visualisation of flavours and ingredients over time—which sometimes co-incide and sometimes diverge.

'Deflection Pool' (left) is a concept for a language learning interface particularly focused on pronunciation, using visualisations of waves in a pool reinforcing or interfering with each other to represent coincident or different pronunciations. Characteristics discussed in the development of the concept included mappings such as loudness of speech to the size of wave, cadence to frequency of wave, warmth of tone to the texture of the wave, and looking at how geographic distribution of languages could be mapped visually onto a 'pool' representing the whole world, or a particular area.

'Virtual University' (right) uses DIFFERENT COLOURED WINDOWS as a metaphor for FINDING IT DIFFICULT TO MAKE A DECISION, applying the idea in the context of students or early-career professionals trying to decide what to study, or whether to go back to college/university or online to study further. The concept is a virtual reality experience which offers 'alternative perspectives for e-learning', using different ways of viewing the 'sea of knowledge' (another metaphor) through windows representing particular subject-based worldviews (art, engineering, law).





'Birdconomy' (left) uses A FLOCK OF BIRDS as a metaphor for THE COUNTRY'S ECONOMY, proposing a form of data visualisation dashboard (and potentially trend forecasting) in which the 'mass' of consumers, and other market participants, acting in certain ways, changing direction, and so on, is expressed through patterns of 'flocking' behaviour around particular nodes, or away from or towards certain elements in the economy. The group who created this were inspired partly by a description one member recalled of the ways in which citizens of an eastern European country changed their consumption behaviour after the fall of the Berlin Wall, as western consumerism spread.

DISCUSSION AND FURTHER WORK

Short workshops such as those illustrated here are inevitably constrained by their format as a way of exploring the potential of new methods; the open-ended nature of the process, with nothing important 'riding on' (note: metaphor) the ideas generated, must have some effects on the ways in which participants use the methods. What works well for idea generation in a workshop setting does not necessarily translate into something which can become part of a designer's everyday workflow—there is potentially a large jump from these ideas to more specific 'solutions'-oriented application.

Nevertheless, in the *New Metaphors* workshops the 180 participants validated the feasibility of the Thing 1–Thing 2 juxtaposition as a generative metaphor process for inspiring new concepts: they generated ideas which (even if just assessed subjectively by their unusualness) were, presumptively, unlikely to have occurred without the prompts of the cards (we did not carry out any kind of 'expert' assessment of the novelty [23], reasoning that with the sheer breadth of ideas, and the arbitrariness of the source material, this was unlikely to provide useful insights). Very few groups 'failed' in the sense that they didn't generate any ideas; there were some ideas that perhaps used a more direct not-so-metaphorical approach (for example, a group used the cards TREE BARK and VIRUSES, BACTERIA AND DISEASES to generate the idea for a hospital treatment room with a 'nature' ambience and plants and trees in it—well illustrated and thought through as an idea, but not using the tree bark as a metaphor so much as a direct inspiration). Others took initial inspiration from the metaphor but developed their ideas further, away from it. Again, this is not necessarily a problem, if the primary aim is to foster creativity rather than to stick rigidly to a particular metaphor.

With a more focused procedure, there is potential for incorporation of a 'metaphor search stage' into design processes; alternatively, there is still potentially value in treating this as a kind of fun creative thinking exercise in itself, to help open up new ways of thinking, even if the concepts generated are not developed further. Participants' comments included insights around how the process had worked in practice—some groups had set themselves the challenge to work with whatever juxtaposition was chosen (even semi-randomly), while others had worked through many different combinations to find ones that 'worked' in terms of structural similarity, or even in being a 'problem' that interested the group. The mapping worksheet had been useful to some groups in working through the characteristics of the phenomena being considered, but other groups had leapt straight to a concept. Some participants and others in their teams have subsequently used the method themselves on projects (e.g. [57]).

One direction for further in-depth research here could be an analysis of how the backgrounds and experience of the participants (which we did not explicitly assess) related to the kinds of ideas generated, or whether particular combinations or attributes of Thing 1 and Thing 2 could apply to certain domains better than others. This work could lead to a much more structured, guided form of ideation process.

The card format

In this pictorial we have not explicitly discussed cards as a format [29; 44]: it is not necessarily obvious that they are the 'right' format here, but their affordances (one idea per 'unit', easy to mix-and-match, easy to rearrange, easy to display) and specifics of the way we did it (A4/Letter size card, larger than usual 'card deck' format, to make group work easier) were relatively easy design choices for us to make. Nevertheless, it would be worth exploring other formats, including variants of image/text combinations. For example, the *Zaltman Metaphor Elicitation Technique* [59] (used in marketing research) uses images without text, to enable participants to read different interpretations into the image. We are, in parallel, exploring digital versions (see the Twitter and SMS bots on page 5 of this paper) and the potential of these as part of a wider field of 'casual creators' [19].

Future directions

There are at least two directions this research could go. One is to use the *New Metaphors* method and cards (suitably expanded or reorganised in content) to generate and iterate more targeted design concepts for new interfaces, products, services, communication campaigns, ways of explaining an idea, or other developments for particular situations and domains, for example new metaphors for interface design around energy use [13], mental health [49], or careers [54].

We are interested in the potential for new metaphors to influence and support decision-making, behaviour change and new practices through enabling new forms of understanding, as an aid to help people explore their own and each other's thinking, and specifically to help people understand their relationships and agency with the systems around them. Practically, we are taking this forward with student projects where the goal is the design, and the *New Metaphors* method is simply part of the process of getting there.

Another direction is to apply the idea of generating new metaphors to bigger situations beyond design: to engage with reframing social, political, or technological issues, involving stakeholders and domain experts from specialist policy and non-profit organisations, or even to use a variant of the method with teams or community groups as part of a co-design process, surfacing existing metaphors and mental imagery, and helping explore the possibilities of transitioning to different ones [43].

In the anthropologist and cyberneticist Gregory Bateson's words, metaphor is a "pattern that connects" [6] two concepts. In some ways, a 'forced connection' method such as *New Metaphors* is a kind of intentionally disruptive improvisation process [1], a creative exercise in finding patterns where maybe none exists, but treating it as if one does—a kind of 'apophenia as method' [46]. People could build their own personal collections of interesting or resonant metaphors, part of a creative journalling practice, and share them with others. Developing ideas along these lines may provide further value for creativity research.

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REFERENCES

1. Kristina Andersen, Laura Devendorf, James Pierce, Ron Wakkary, and Daniela K. Rosner. 2018. Disruptive Improvisations: Making Use of Non-Deterministic Art Practices in HCI. In Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18). ACM, New York, NY, USA, Paper W11, 8 pages. DOI: https://doi.org/10.1145/3170427.3170630
2. Michelle Annett, Matthew Lakier, Franklin Li, Daniel Wigdor, Tovi Grossman, and George Fitzmaurice. 2016. The Living Room: Exploring the Haunted and Paranormal to Transform Design and Interaction. In Proceedings of the 2016 ACM Conference on Designing Interactive Systems (DIS '16). ACM, New York, NY, USA, 1328-1340. DOI: https://doi.org/10.1145/2901790.2901819
3. J.G. Ballard. 2012. Extreme Metaphors: Interviews with J.G. Ballard, 1967-2008. (eds. Simon Sellars and Dan O'Hara). Fourth Estate, London.
4. Pippin Barr, Robert Biddle, and James Noble. 2002. A taxonomy of user-interface metaphors. In Proceedings of the SIGCHI-NZ Symposium on Computer-Human Interaction (CHINZ '02). ACM, New York, NY, USA, 25-30. DOI: http://dx.doi.org/10.1145/2181216.2181221
5. Mary Catherine Bateson. 1984. With A Daughter's Eye. William Morrow, New York.
6. Gregory Bateson. 1972. Steps to an Ecology of Mind. University of Chicago Press, Chicago.
7. Eric Baumer, Bill Tomlinson, Lindsey E. Richland, and Janice Hansen. 2009. Fostering metaphorical creativity using computational metaphor identification. In Proceedings of the seventh ACM conference on Creativity and cognition (C&C '09). ACM, New York, NY, USA, 315-324. DOI: http://dx.doi.org/10.1145/1640233.1640280
8. Michael Mose Biskjaer, Peter Dalsgaard, and Kim Halskov. 2017. Understanding Creativity Methods in Design. In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17). ACM, New York, NY, USA, 839-851. DOI: https://doi.org/10.1145/3064663.3064692
9. Alan F. Blackwell. 2006. The Reification of Metaphor as a Design Tool. ACM Transactions on Computer-Human Interaction (TOCHI), 13(4), 490–530.
10. Margaret A. Boden. 1992. The Creative Mind: Myths and Mechanisms. Abacus, London.
11. Edward de Bono. 1971. The Use of Lateral Thinking. Pelican, Harmondsworth.
12. Gautam Bose, Marisa Lu, Lucas Ochoa and Dan Lockton. 2019. Emoto: From Phone to Emotive Robotic AI Sidekick. In Proceedings of ACM TEI 2019: 13th International Conference on Tangible, Embedded, and Embodied Interactions.
13. Flora Bowden, Dan Lockton, Rama Gheerawo and Clare Brass, 2015. Drawing Energy: Exploring perceptions of the invisible. Royal College of Art, London.
14. Kenneth Burke. 1945. A Grammar of Motives. Prentice-Hall, New Jersey
15. Hernan P. Casakin. 2007. Factors of metaphors in design problem-solving: Implications for design creativity. International Journal of Design, 1(2), 21–33.
16. Yoony Choi, Dan Lockton, Clare Brass and John Stevens, J. 2015. Opportunities for sustainable packaging design: Learning from pregnancy as a metaphor. In Proceedings of Sustainable Innovation 2015, 9-10 November 2015, Epsom, UK
17. Nazlı Cila. 2013. Metaphors we design by: The use of metaphors in product design. PhD thesis, TU Delft.
18. Gabriel Cirio, Maud Marchal, Tony Regia-Corte, and Anatole Lécuyer. 2009. The magic barrier tape: a novel metaphor for infinite navigation in virtual worlds with a restricted walking workspace. In Proceedings of the 16th ACM Symposium on Virtual Reality Software and Technology (VRST '09), Steven N. Spencer (Ed.). ACM, New York, NY, USA, 155-162. DOI: http://dx.doi.org/10.1145/1643928.1643965
19. Kate Compton and Michael Mateas. 2015. Casual Creators. Proceedings of the Sixth International Conference on Computational Creativity.
20. Kate Compton, Joseph C. Osborn and Michael Mateas. 2013. Generative Methods. Foundations of Digital Games 2013, PCG Workshop.
21. Laura Devendorf and Daniela K. Rosner. 2017. Beyond Hybrids: Metaphors and Margins in Design. In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17). ACM, New York, NY, USA, 995-1000. DOI: https://doi.org/10.1145/3064663.3064705
22. Josh Dillon, Daniel Dranove, Eli Halpern, Ben Hantoot, David Munk, David Pinsof, Max Temkin, and Eliot Weinstein. 2009. Cards Against Humanity. Cards Against Humanity LLC, Chicago.
23. Kees Dorst and Nigel Cross. 2001. Creativity in the design process: co-evolution of problem solution. Design Studies, 22(5), 425–437
24. Michael Erard. 2015. See through words. Aeon, 9 June 2015. https://aeon.co/essays/how-to-build-a-metaphor-to-change-people-s-minds

25. Jonas Frich, Michael Mose Biskjaer, and Peter Dalsgaard. 2018. Why HCI and Creativity Research Must Collaborate to Develop New Creativity Support Tools. In Proceedings of the Technology, Mind, and Society (TechMindSociety '18). ACM, New York, NY, USA, Article 10, 6 pages. DOI: https://doi.org/10.1145/3183654.3183678

26. Bill Gaver. 1995. Oh what a tangled web we weave: metaphor and mapping in graphical interfaces. In Conference Companion on Human Factors in Computing Systems (CHI '95), I. Katz, R. Mack, and L. Marks (Eds.). ACM, New York, NY, USA, 270-271. DOI: http://dx.doi.org/10.1145/223355.223669

27. Dedre Gentner and Brian Bowdle. 2008. Metaphor as structure-mapping. In R. W. Gibbs, Jr. (Ed.), The Cambridge Handbook of Metaphor and Thought. Cambridge University Press, Cambridge. 109-128.

28. Katy Ilonka Gero and Lydia B. Chilton. 2019. Metaphoria: An Algorithmic Companion for Metaphor Creation. In Proceedings of the 37th Annual ACM Conference on Human Factors in Computing Systems (CHI '19). ACM, New York, NY, USA.

29. Michael Golembewski and Mark Selby. 2010. Ideation decks: a card-based design ideation tool. In Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS '10). ACM, New York, NY, USA, 89-92. DOI: http://dx.doi.org/10.1145/1858171.1858189

30. Richard Harper, Siân Lindley, Eno Thereska, Richard Banks, Philip Gosset, Gavin Smyth, William Odom, and Eryn Whitworth. 2013. What is a file?. In Proceedings of the 2013 conference on Computer supported cooperative work (CSCW '13). ACM, New York, NY, USA, 1125-1136. DOI: https://doi.org/10.1145/2441776.2441903

31. N. Katherine Hayles. 2001. Desiring Agency: Limiting Metaphors and Enabling Constraints in Dawkins and Deleuze/Guattari. SubStance # 94/95: 144–159.

32. Douglas R. Hofstadter (2001). Analogy as the core of cognition. In D. Gentner, K. J. Holyoak, & B. N. Kokinov (Eds.), The Analogical Mind: Perspectives from Cognitive Science. MIT Press, Cambridge. 499–538

33. Yvonne Jansen, Pierre Dragicevic, Petra Isenberg, Jason Alexander, Abhijit Karnik, Johan Kildal, Sriram Subramanian, and Kasper Hornbæk. 2015. Opportunities and Challenges for Data Physicalization. In Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15). ACM, New York, NY, USA, 3227-3236. DOI: https://doi.org/10.1145/2702123.2702180

34. Heekyoung Jung, Heather Wiltse, Michael Wiberg and Erik Stolterman. 2017. Metaphors, materialities, and affordances: Hybrid morphologies in the design of interactive artifacts. Design Issues 53: 24-46.

35. Darius Kazemi. 2012. How I built Metaphor-A-Minute. Tiny Subversions. 15 May, 2012. http://tinysubversions.com/2012/05/how-i-built-metaphor-a-minute/

36. Arthur Koestler. 1964. The Act of Creation. Hutchinson, London.

37. George Lakoff, 2002. Moral Politics: How Liberals and Conservatives Think. University of Chicago Press, Chicago.

38. George Lakoff and Mark Johnson. 1980. Metaphors We Live By. University of Chicago Press, Chicago.

39. Chang Hee Lee, Dan Lockton, John Stevens, Stephen Jia Wang, SungHee Ahn. 2019. Synaesthetic-Translation Tool: Synaesthesia as an Interactive Material for Ideation In Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (CHI EA '19). ACM, New York, NY, USA.

40. Congmin Li and Jie Li. 2017. Using sunflower metaphor to reduce clutter of scatterplot. In Proceedings of the 10th International Symposium on Visual Information Communication and Interaction (VINCI '17). ACM, New York, NY, USA, 65-66. DOI: https://doi.org/10.1145/3105971.3108443

41. Siân E. Lindley, Gavin Smyth, Robert Corish, Anastasia Loukianov, Michael Golembewski, Ewa A. Luger, and Abigail Sellen. 2018. Exploring New Metaphors for a Networked World through the File Biography. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18). ACM, New York, NY, USA, Paper 118, 12 pages. DOI: https://doi.org/10.1145/3173574.3173692

42. Dixon Lo, Dan Lockton, and Stacie Rohrbach. 2018. Experiential Augmentation: Uncovering The Meaning of Qualitative Visualizations when Applied to Augmented Objects. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18). ACM, New York, NY, USA, Paper 490, 8 pages. DOI: https://doi.org/10.1145/3173574.3174064

43. Dan Lockton and Stuart Candy. 2018. A Vocabulary for Visions in Designing for Transitions. In Proceedings of DRS 2018: Design Research Society, 25–28 June 2018, Limerick.

44. Dan Lockton, David Harrison, and Neville A. Stanton. 2013. Exploring design patterns for sustainable behaviour. The Design Journal 16(4), 431-459.

45. Dan Lockton, Delanie Ricketts, Shruti Aditya Chowdhury, and Chang Hee Lee. 2017. Exploring Qualitative Displays and Interfaces. In Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '17). ACM, New York, NY, USA, 1844-1852. DOI: https://doi.org/10.1145/3027063.3053165

46. Dan Lockton, Some Cracks In The Paving and Water Trapped In The Window Of A British Rail Class 450 Train Carriage. 2018. Apophenia As Method—Or, Everything Is Either A Metaphor Or An Analogue Computer. Disruptive Improvisation: Making Use of Non-Deterministic Art Practices, workshop at CHI 2018: ACM Conference on Human Factors in Computing Systems, 21–26 April 2018, Montreal

47. Nick Logler, Daisy Yoo, and Batya Friedman. 2018. Metaphor Cards: A How-to-Guide for Making and Using a Generative Metaphorical Design Toolkit. In Proceedings of the 2018 Designing Interactive Systems Conference (DIS '18). ACM, New York, NY, USA, 1373-1386. DOI: https://doi.org/10.1145/3196709.3196811

48. Michal Luria. 2018. Designing Robot Personality Based on Fictional Sidekick Characters. In Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction (HRI '18). ACM, New York, NY, USA, 307-308. DOI: https://doi.org/10.1145/3173386.3176912

49. Michal Luria, Jennifer Brown, Katie Herzog, Laura Rodriguez, Supawat Vitoorakaporn, Josh LeFevre, Suzannah Mills, Carlie Guilfoile, Nowell Kahle, Kailin Dong, Jessica Nip, Aisha Dev, Katie Glass, Zhiye Jin, Soonho Kwon, Arden Wolf and Dan Lockton. 2019. Potions, Rocks, Models, and Lexicons: Materializing Mental Health Using Design Methods. Working paper.

50. New Economy Organisers' Network, New Economics Foundation, FrameWorks Institute, an Public Interest Research Centre. 2018. Framing The Economy: How to win the case for a better system. New Economics Foundation, London.

51. Dietmar Offenhuber and Orkan Telhan. 2015. Indexical Visualization—the Data-Less Information Display. In Ulrik Ekman, Jay David Bolter, Lily Diaz, Morten Søndergaard, and Maria Engberg (eds.). Ubiquitous Computing, Complexity and Culture: 288–303. Routledge, New York

52. James Pierce and Carl DiSalvo. 2017. Dark Clouds, Io&#!+, and [Crystal Ball Emoji]: Projecting Network Anxieties with Alternative Design Metaphors. In Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17). ACM, New York, NY, USA, 1383-1393. DOI: https://doi.org/10.1145/3064663.3064795

53. Roger Price and Leonard Stern. 1958. Mad Libs: World's Greatest Party Game. Price/Stern/Sloan, Los Angeles.

54. Delanie Ricketts and Dan Lockton, 2019. Mental Landscapes: Externalizing Mental Models Through Metaphors. Interactions 26(2), 86–90.

55. Donald Schön. 1979. Generative Metaphor: A perspective on problem-setting in social policy. In: Andrew Ortony (ed.), Metaphor and Thought. Cambridge University Press.

56. Bernard Scott. 2016. Cybernetic Foundations for Psychology. Constructivist Foundations 11(3), 509–517

57. Joseph Seering, Michal Luria, Geoff Kaufman and Jessica Hammer. 2019. Beyond Dyadic Interactions: Considering Chatbots as Community Members. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). ACM, New York, NY, USA

58. Sara M. Watson. 2015. Data is the New "___": Sara M. Watson on the Industrial Metaphors of Big Data. DIS Magazine, 2015. http://dismagazine.com/discussion/73298/sara-m-watson-metaphors-of-big-data/

59. Gerald Zaltman and Lindsay H. Zaltman. 2008. Marketing Metaphoria: What Deep Metaphors Reveal About The Minds Of Consumers. Harvard Business Press, Cambridge MA.