Perhaps humanity's defining trait is our ability to craft elegant solutions in face of adversity, complexity, and scarcity. Starting from our early ancestors who fashioned their tools using little more than wood, stone, and sinew to the more recent inventions of steam and electric engines, our history is testament to transformations in our societies on the strengths of our solutions. Some transformations are an intended consequence of the invention, such as the use of steam engines to make faster travel possible. Other consequences are unintended, such as the excessive pollution created as a consequence of our industrialized societies.

Colorful packaging and a plastic-filled sea. © *The Guardian & CoastalCare*

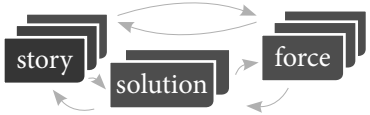
Making elegant solutions becomes harder as our societies grow more complex. A solution with a physical form, such as a household appliance, must provide utility, possess ergonomic qualities, utilize materials that do no harm its users, and withstand a variety of situations both intended and accidental. A solution that consists of several interrelated solutions, such as an office building with specialised rooms, must be able to balance individual and collective needs. An intangible solution, such as a business practice or procedure, must be learnable and teachable, be adaptive to varying situations, and be capable of refinement with usage.

Metropolises concentrate complexity. © *Puku/SIME-4Corners Images*

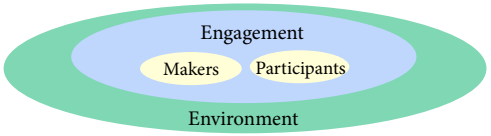
Yet we are capable of dealing with complexity from an early age by probing, learning, and through repeated application, forming practices to the extent of some becoming habits. Novice car drivers, for instance, have to expend significant effort to master a vehicle's controls and traffic rules, which with practice becomes a relatively effortless activity. Coping with complexity can make us habituated to existing solutions, and blinding us to new opportunities. By cultivating a perpetual curiosity of the kind best embodied by toddlers, and possessing an ability to be formed and reformed like wet clay on a potter's wheel, we become better makers.

Shaping wet clay and undiluted curiousity © *Wayne Arts Center & Bebé Feliz*

How do we ensure our solutions bring about positive changes in our societies and avoid creating unintended consequences such as waste or pollution? Embodied making is a method for realizing solutions for complex environments with a high scale of interwoven problems. Solutions are realised together with the people who live and work in those environments every day by first understanding and recording their experiences in the form of stories. Stories provide insight about the forces that shape an environment, such as a story about the lack of inter-departmenal cooperation in a company can reveal several forces, one of which can be departmental goals taking precedence over organisational goals. Through deep contemplation about the body of forces revealed through several stories, solutions can be discovered that solve the these forces in the most elegant manner.



How do ensure our solutions truly solve the problems posed by an environment rather than satisfying our needs as designers or makers first, such as an affinity with a trend? Or that our solutions aren't the result of our limited knowledge or familiarity with a breed of solutions? Embodied making is also an attitude for problem solving through the appreciative participation of the people who live and work in that environment. Embodied makers work with rather than for people, play a facilitative role in understanding an environment by faithfully recording narratives as they are related to them, possess a learning attitude to understand the complexity present in an environment, and are adept at coming up with solutions that balance forces elegantly by being deeply critical of their own ideas through introspection.



Embodied making is applied in the same way to make household appliances, software systems, organisations, or cities. It complements other methods of analysis, engineering, construction, and manufacturing by helping understand and structure genuine needs, qualitative criteria, and intangibles such as influence and power. Environments with high complexity usually require makers to use structured techniques for recording, categorising and visualising stories, forces, and solutions. Mastery in the method is gradually obtained when makers are able to extract and refine the formative stories in an environment, cognitively balance a high scale of forces, and formulate solutions that resolve forces and embrace stories elegantly.

Humans possess an extraordinary ability to craft the environment around them into all sorts of useful objects, ranging from cups, bicycles, paper to door handles. Even more extraordinary is our ability to learn about these objects, and with a little practice, use them seemingly little thought. When we drink a hot beverage from a familiar cup, we expend little thought into that first careful sip to gauge temperature, the measured sips as the beverage cools, and the carefree swigs after the beverage has cooled. If we want to drink a hot beverage over a good conversation with a friend, we may use a large cup, so that it can contain enough coffee or tea to last the whole conversation, thick enough not to scald our fingers, yet thin enough to warm or hands on a cold winter evening, and with large handles to afford nestling several fingers to lift its heavy contents and body. To drink a glass of water, we would probably use a clear glass so that we can can hold it up to sunlight to ensure that the water is free from floating particles, broad enough so we can encircle all of our fingers to get a firm grip, with a heavy base so that it doesn't topple over easily, and tall enough to quench our thirst. The shape of cups and glasses have held a stable form as the manner in which we drink from them has not changed since their inception. Adaptation, if at all, has occurred with the emergence of new materials and methods of ornamentation to balance the forces around their cleaning (e.g. dishwashing machines), usage (e.g. heating in microwaves), and storage (e.g. refrigerators). In contrast, the forms of clothing for the same human form around the world have near infinite variety reflecting the varying forces of climate, vegetation, culture, belief systems, community, and individuality. Some clothing trends such as hoop skirts and whalebone corsets were short-lived, partially because they relied on unsustainable practices like extensive whaling. Sarongs, shirts, tunics, and trousers, on the other hand, have a timeless appeal by their ability to resolve a large scale of forces consistently over time. Making timeless and elegant forms is hard, as the forces that seem stable today may not be so for long. Embodied making helps understand complexity to make such timeless forms.

an applied example of embodied making

The process of design with embodied making starts with listening to people in the space where we want our designs to live and rest. Stories are anecdotes as people relate them to us, and these are faithfully recorded *as they are told to us.*

1. "We share 10 meeting rooms, usually named after people to identify them, between 300 people, and the meeting rooms need to be kept locked."
2. "The receptionist helps book the room, and room users pick up the key, and usually drop it back."
3. "Although people are supposed to pick up and drop off the key with me, they rarely do. I have to run around and try and trace where the keys are."
4. "I often have back-to-back meetings, and I don't always have time to return the key."
5. "We lose keys to meeting rooms all the time and have to replace all the locks 3 or 4 times a year."
6. "We need presentation equipment for meetings."

Stories should be gathered from several perspectives. In the example of the meeting room, stories from the users of meeting rooms, building security, receptionists, moderators of meetings, visitors to the building to who come for a meeting, maintenance staff, or cleaning staff will help create a rich tapestry as the basis of designs. As we catalog more and more stories from

What induces people to behave in the way they do in their environments? Or motivates them to decide on a particular course of action? These factors are called forces in embodied making. We can identify some of these forces from the stories:

1. F01. Meeting rooms are shared by a lot of people.
   F02. Meeting rooms contain expensive equipment.
   F03. Desire to protect equipment in meeting rooms.
   F04. Limited number of meeting rooms.
2. F05. Meeting rooms are booked with a single point.
   F06. Desire to pick up meeting room keys in 1 place.
   F07. Desire to return keys in 1 place.
3. F08. Tendency for people to not return keys.
   F09. Difficulty in tracking down unreturned keys.
4. F10. Individuals have several meetings without gaps.
   F11. Returning keys is often inconvenient.
5. F12. Frequent loss of meeting room keys.
   F13. Inability to distinguish keys of meeting rooms.
6. F14. Use of high-quality equipment in meetings.

different perspectives, more and more forces will emerge. The objective of enumerating forces isn't to try and find as many forces as possible. In order to give designers a feeling of the space where their designs will live and rest, the objective is to capture an adequate number of forces for reflection. Understanding the interactions between forces helps designers live and ex-

If we are able to find an elegant solution that is both stable and reliable, and this solution would be able to balance all of these forces (let's assume for now that these stories and forces are complete), we would have created a system that would fulfill the requirements of sharing meeting rooms effectively. We can gain insight into how these forces exist in their environments by exploring how they interact with each other, by placing a (+) sign for a pleasant experience, a (-) sign for an unpleasant experience, and (~) for a neutral experience.

F01 :: -F03, -F04, +F05, +F06, +F07, -F08, -F09, -F10, -F12, -F13
F02 :: -F03, -F08, -F09, -F12, -F13
F03 :: -F01, -F02, +F04, +F05, -F08, -F09, -F11, -F12, -F14
F04 :: -F01, F02, +F03, -F08, -F09, -F10, -F11, -F12, -F13
F05 :: +F01, +F06, +F07, -F08, -F09, -F10, -F11, -F12, -F13
and so on and so forth for F06 to F09
F10 :: -F01, -F04, +F05, -F11, -F12, -F13
F11 :: -F01, -F02, -F03, -F04, -F05, -F06, -F07, +F10, -F13
F12 :: -F01, -F02, -F03, -F04, -F05, -F06, -F07, +F08, +F09, +F10..
F13 :: -F01, -F02, -F05, -F06, -F07, -F08, -F09, -F11, -F12

perience them. For each interaction, try and imagine situations where those interactions between forces would occur. By thinking about each interaction, you will increasingly understand how all of these forces co-exist in the same space. Understanding the complex interactions has a meditative quality, and after while, a feeling of "living" the forces occurs for the designer. Throughout

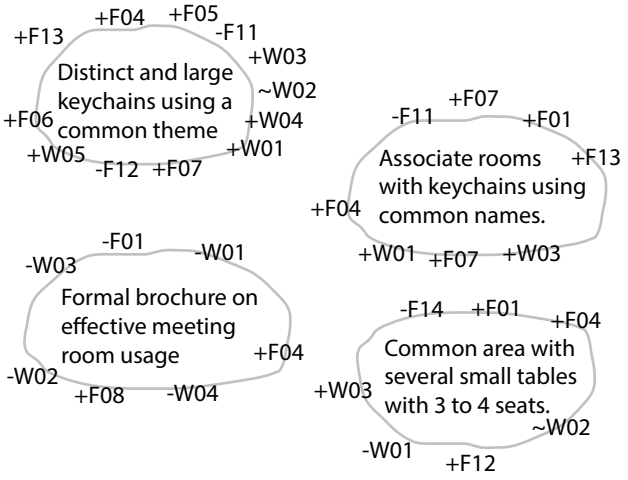
As designers, we must also be conscious of our own will, and that our involvement in the design process, and the systems we realize from those designs, actively transform the environment.

W01. Desire for low cost solutions
W02. Desire not to inconvenience meeting room users.
W03. Desire to keep organizational culture intact.
W04. Desire to make meeting room usage fun.
W05. Desire to use of common locks and keys.

There is no clear or sharp distinction between wills and forces. They come from two directions. Wills comes from self awareness of the designer or requirements of the patron, and forces come from observation of patterns of behavior, culture, or nature in the design environment. By integrating the perspectives of wills and forces, designers can propose solutions that 'work'.

this process, the personal goals and objectives of the designer or designers should be explicitly stated as wills. Interactions between wills and forces reveal their conduciveness to exist in the same space. As we think about the forces, and the interactions between forces, ideas will flow on how to resolve them. Each idea should be written down as a solution component, examining

An understanding of the forces and wills gives insight into the solutions that would be most likely to resolve them.



how it helps resolves the immediate forces we have considered, and all the forces that emerge afterwards. There is no fixed sequence on writing any of them down. In this example, we want to create compassion and empathy, and we can achieve this by finding analogies or metaphors that inspire those emotions. As there is a natural tendency for human beings to care for their

pets, associating the keys to animals transfers some of this care to the keys. Animals should be selected for the vulnerability, and a connection to the planet can be found through featuring endangered animals. By introducing gameplay at the key moments when keys are the most likely to go missing, moments susceptible to mishap can be averted.