PART 2
Concepts of Product Form

PART 3
Product Form in Practice

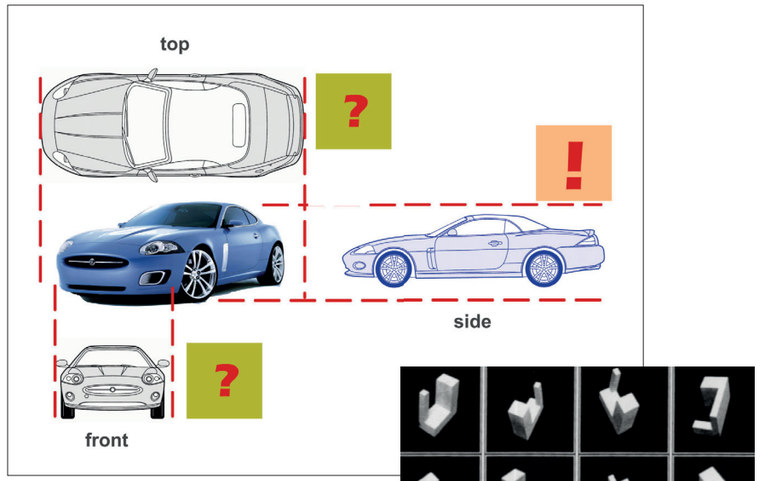
POSTSCRIPT
...but what is it?

objects. Different connections of the same geons can lead to different objects as a cup or a bucket (fig. 4, right).

Object identification involves finding the relationships between the separate geon components of the object, thus leading to a geon structural description (GSD) that lists the geons, their attributes, and their relations with adjacent geons. It is this structural description that provides a solution to viewpoint invariance: if two different spatial views of an object result in a similar GSD, they should be treated as equivalent by the object recognition system (fig. 5).

We designers feel at ease with the geon theory. Is it not the same approach as we are used to in building objects in 3D design software: using essentially the same basic primitives and then combining them together, manipulating them and then adding a layer of details? But it is not so simple, unfortunately. The geon theory is still inadequate to most cognitive scientists since it does not explain how the brain deconstructs an object into its geon primitives.

Marr and Nishihara (1978) suggested a higher-level approach to structure-based object recognition that resolves the geon theory weakness. They suggested that concave sections of the silhouette contour are critical in defining how different solid parts are perceptually defined (fig.6). A roughly drawn animal can readily be segment into generalized cones representing the head body, neck, legs, etc. Based on the resulting segmentation the brain reads a simplified form made from skeletal cylinders. Recognition is acquired when the observed object viewpoint is mentally rotated to match the stored archetypal description in the brain (fig. 7).

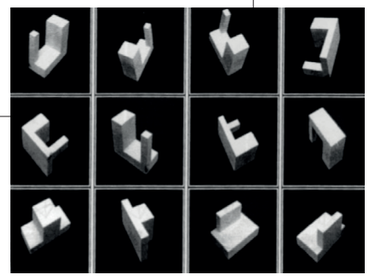


8. WE CAN MENTALLY REVOLVE OBJECTS IN ORDER TO EXTRACT DEFINING VIEWS

As I have mentioned before, not one theory carries the day. Recent experiments suggest the brain employs a combination of the geon theory and the Marr and Nishihara model.

View-dependent theory: Children tend to draw objects on the basis of the most form-defining silhouettes. Many objects have defining silhouettes that are easily recognizable—a house, a teapot, a person, or a car (fig. 8, left). These canonical

9. WE FEEL AT HOME WITH CONTOUR BASED OBJECT RECOGNITION (BOTTOM IMAGES)



silhouettes are often based on a particular view of an object, often from a point at right angles to a major plane of symmetry. Thus the researchers consider silhouettes to be especially important in determining how we perceive the structure of objects. They argue that buried in our brain are mechanisms that determine how silhouette information is interpreted.

Contour-propagation theory: (Tse, 2002) This theory is based on the fact that we can easily read 3D shapes even if drawn in silhouette and/or line drawings, such as comic strips (fig. 9). This capability is amazing, given both the scarcity of information in such images and the fact that no object in the world looks like a line drawing, or like contours without any surface information. The word propagation in this theory means that mental processing may involve not only the contour information but also considers information residing away from edges and inside the flat surfaces.

Neuroscience Research: insights into perception

Until the 21st century, science and medicine were restricted in performing invasive investigations of the brain. Therefore, our knowledge of the mind was based on behavioral and cognitive changes that appear in patients following a stroke or brain injury. Visual agnosia is the neuropsychology term for the inability of the brain to recognize or understand visual images. This impairment is usually seen in older people as a result of damage to the visual association cortex of the brain. An individual with visual agnosia has otherwise normal visual functioning and can see, but is unable to interpret or recognize what he sees, be it human faces or objects. Judging from the effect of localized brain injuries, researchers found that object memory tends to be grouped and located in the cortex corresponding to the nature of the images—faces, animals, man-made objects, etc. Strangely, animal recognition and object recognition are located in the same cortex area. This and other evidence led to the conclusion that image grouping is based mainly on the frequency and strength of memory acquisition. (A popular portrayal of visual agnosia is presented in Oliver Sacks' popular book, *The Man Who Mistook His Wife for a Hat*, as the title implies).

A classic experiment by Palmer, published in 1975, investigated whether the context in which an object is seen affects the perception of that object. Participants were most likely to identify objects correctly after previously seeing an appropriate context (for example, a photo of a kitchen table and then a photo of a bread loaf) and less likely to do so after seeing an inappropriate context (for example, a photo of a dilapidated house followed by a photo of a Rolls Royce in the garage). Furthermore, identification was worse when objects were in conflicting contexts even when compared to when there was no context at all. Palmer established the concept of schema—the way we perceive is affected by what we already know. A schema is a mental structure that holds our knowledge about a particular type of object, event, or group of people (fig. 10). It seems that our mind habitually searches for meaning—when presented with a random series of images or statements, the mind tries to put them together in a way that tells a meaningful, coherent story.

10. (LEFT) VISUAL PRIMING: THE FIGURE IN THE MIDDLE YOU SEE AS EITHER 13 OR B DEPENDING ON SCHEMA; (RIGHT) YOU READ "EIGHT" BECAUSE THE LETTERS ARE DRAWN FROM THE NUMERAL 8

Lupyan and Ward (2013) at the University of Wisconsin-Madison showed in a series of experiments that Language seems to enhance or block our visual perception. Students were presented with images of familiar objects in one eye and strong light flashes in the other eye that suppressed the perception of these objects. Hearing the name of the object prior to the flashes made them overcome that suppression and identify the object faster than with no cue at all. On the other hand, hearing a wrong name worsened their performance. Lupyan and ward concluded that language can enhance the sensitivity of visual awareness. It seems that, often, visual perception involves making inferences from incomplete information, and the brain is used to filling the gaps to make the best guess about what we see. The right word may prime our guess in the right direction. In the words of the authors, here are the implications:

... if we consider that the real purpose of perceptual systems is to help guide behavior according to incomplete and underdetermined inputs, and that perception is at its core an inferential process, then perception needs all of the help it can get. If tuning the visual system can make it more sensitive to a class of stimuli or a perceptual dimension that is currently task-relevant, then having a highly permeable perceptual system that allows for influences outside vision, including language, can be viewed as highly adaptive. Indeed it is perhaps this power of language to modulate processing on demand—from perception onward—that makes it so effective in guiding behavior.

The majority of brain researchers in the first half of the twentieth century believed that cognitive processing in the brain is carried out in separate streams that do not influence each other. For example language and vision are distinct and separate processes. New neuroscience research reveals the existence of complex neural networking in the brain. Thanks to the emergence of new non-invasive real-time brain imaging technologies such as Positron Emission Tomography (PET) and Functional Magnetic Resonance Imaging (fMRI), which measures brain activity by detecting changes in oxygenated blood flow in the brain (fig. 11), researchers can follow patterns of brain activation in real time, while their test subjects respond to given experiments. The researchers can detect which areas of the brain are activated and to what degree. As it turns out, often several brain centers and cortex areas are highlighted concurrently during tasks.

The various concepts of cultural and technological evolution presented in this chapter almost call for one overall encompassing view, a contemporary successor of Philip Steadman's book. This is a monumental task, out of the scope of this book. Others did try to tackle this issue, at least in part.

For example, Sjostrom and Donnellan, in a paper presented in 2012, *Design Research Practice: A Product Semantics Interpretation*, talk about the meaning of an ecology of artifacts on the basis of Krippendorff's proposal that designers need to recognize the meaning of ecology of artifacts (see the next chapter). They write, "Designers who can handle the ecological meaning of their proposals have a better chance of keeping their designs alive." People attach meaning to artifacts in relation to other artifacts. This relationship can span a number of dimensions such as cooperation, competition, interdependence, reproduction, and retirement (death) of artifacts in specific contexts. The most obvious example from a technical perspective is that artifacts depend on infrastructure. However, there are other relations in ecology of artifacts, such as competing artifacts, or artifacts that 'thrive' through the existence of other artifacts. The point stressed in that paper is that the meaning of a single artifact is based on its place within a larger ecology.

Bruce Sterling, a science fiction author and futurist, wrote a highly original manifest in a small book called *Shaping Things*. Sterling offers a brilliant, often hilarious, history of shaped things. He analyses how the tools that designers deliver change society, and how that changes us, and that leads again to design changes. Sterling traces the history of tools from artifacts (farmers' tools) to machines (customers' devices) to products (customers' purchases) to current gizmos (end-users' platforms) and to the future, which is defined by what Sterling calls spimes. A spime is a location-aware, environment-aware, self-logging, self-documenting, uniquely identified object that throws off data about itself and its environment in great quantities. A universe of spimes is an informational universe, and it is the use of this information that informs the most exciting part of Sterling's argument.

Reviewing the designed form

Design and form

> **To design is much more than simply to assemble, to order, or even to edit; it is to add value and meaning, to illuminate, to simplify, to clarify, to modify, to dignify, to dramatize, to persuade, and perhaps even to amuse.**
>
> **Paul Rand**, noted American graphic designer, 1914-1996

In this chapter we will investigate how designers considered form and form evolution of products. Understandably, in the century that industrial design existed as an established profession, the way designers studied form has changed considerably, from mere visual description of style to establishing theories based on scientific investigation methods, not to forget evidence gathered from other fields. This chapter will deal with several aspects of the accumulated theory. In the next chapter, *In Context 1: Aesthetics of form*, I will further elaborate on that specific topic.

As I have stated in the preface to this book, though physical form has always been a mainstay of product design, it was often played down or even neglected, being popularly labeled as only skin deep or as pure "styling." At the end of the day, whatever the method they use, product designers create a physical entity—a form. We should openly recognize that form and aesthetics are indispensable elements not only of the design profession, but of our "object oriented" contemporary culture.

For a good illustration of how our attitude-by-language has changed, moving from the physical, through the emotional, and into the realm of our zeitgeist, follow Donald Norman's series of books on products: *The Design of Everyday Things* (1998), *Emotional Design: Why We Love (or Hate) Everyday Things* (2004), and his recent *Living with Complexity* (2010).

Early inquiry of form

As I stated in the preface, discussion about aesthetics and form for at least four hundred years was the exclusive territory of art historians. Art historians tend to embrace the creative genius, the personal contribution of the individual to art and art history. Historians also emphasize the chronology of art movements, separated into modes of presentation: architecture, painting, and sculpture. Unfortunately, design as a creative discipline was considered by art historians as a minor art and not as significant as other artistic modes.

Historical research calls for substantial time perspective in order to grasp and describe an objective picture of the period. Industrial design of man-made products is still a very young profession. As a discipline, history of design is by far even younger. Though substantial research was already carried out, design history, even by design historians, often follows the established art history tradition, albeit with improved understanding of tool-making and technological development and with lesser bias against style and form decoration. Still, celebrating landmark works by known designers, admittedly often being trendsetters, counted much more than did recording overall design trends perceived from the glut of everyday manufactured articles. The founding of serious design-research journals, design societies, and conferences dedicated to the study of man-made products and their interaction with users brought about interest in form-centered research, a glimpse into it will be given later in this chapter.

On the nature of form

In 1896, the American architect Louis Sullivan coined his famous principle *Form Follows Function*. It was a turning point in the history of art and design. The Sullivan design principle entails the belief that the form of tangible products would emerge naturally from a clear understanding of the function they are to serve. This design principle was the beacon, and in its light, modernism followed. Nowadays, we may understand Sullivan's dictum as merely a disapproval of the prevalent overly ornate style of the Victorian Era as culminated in the Crystal Palace of 1871 (fig. 1).

1. VICTORIAN TASTE IN FURNITURE DESIGN

PART 2

Concepts of Product Form

Temporal aspects of form evolution

Temporal (adj.)
Of or relating to time.

Collins English Dictionary

The Cyclical Evolution in Art tenet

History does not repeat itself, but it does rhyme.

Mark Twain

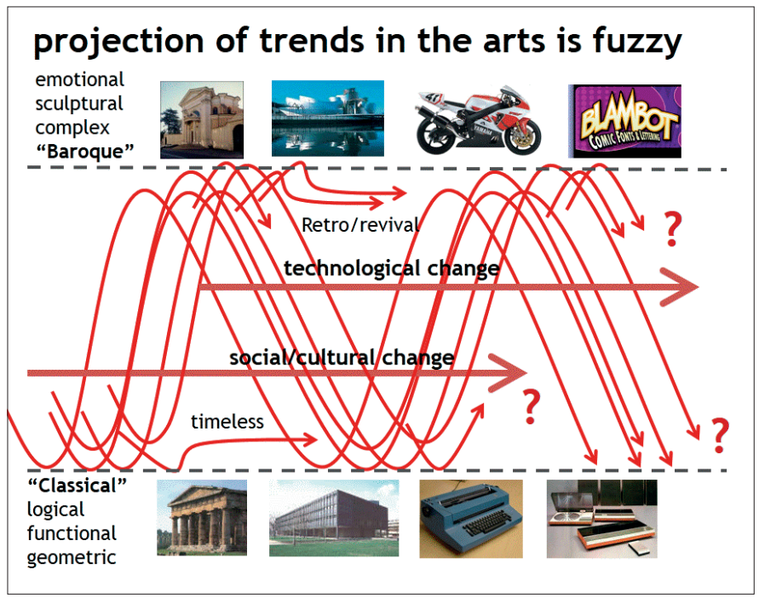
People usually associate technological progress and, in general, human progress with exponential growth, or at least to accelerated change behavior, eventually reaching a plateau: the S-curve (fig. 1). Several thinkers even talk about exponential growth reaching a point of *singularity*. The renowned writer on singularity, Ray Kurzweil, defines the singularity concept in terms of the technological creation of superintelligence, and argues that it is difficult or impossible for present-day humans to predict what a post-singularity world would be like, due to the difficulty of imagining the intentions and capabilities of superintelligent entities.

Unlike most theories of social evolutionism, which view the evolution of society and human history as progressing in unique ways, Sociological Cycle Theory argues that events and stages of society and history are generally repeating themselves in cycles. Such a theory does not necessarily imply that there cannot be any social progress. Similar cyclical theories are found in economics: Kondratiev waves, also called supercycles, are described as sinusoidal-like cycles between fast and slow growth in the modern capitalist world economy, averaging about fifty years from peak to peak.

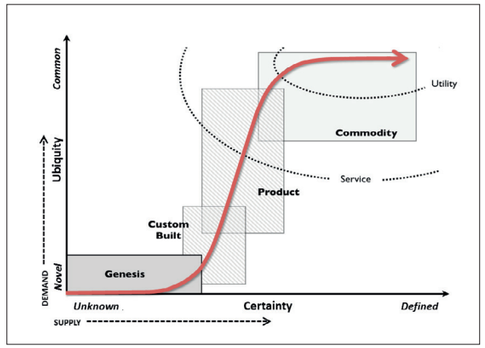
Closer to our topic, fashion is ultimately cyclical, based on the annual seasonal cycle of summer, winter, and *demi-saison*. However, next year's fashion will certainly not be a strict copy of this year's.

Is there also a cyclical component in the design of man-made objects? I wish to distinguish between the technological aspects, which usually grow exponentially (as in Moore's Law) and the visual contents aspects, which comprise our interest here. To answer this question we may draw an inference from arts. What does art have to do with anything here? Britannica Online defines art as "the use of skill and imagination in the creation of aesthetic objects, environments, or experiences that can be shared with others." This definition clearly embraces man-made objects of design as being art.

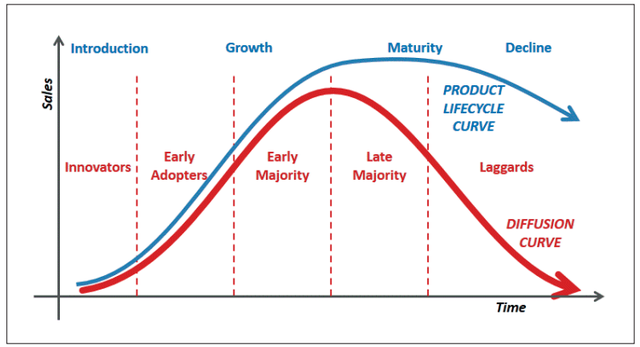
It seems that man-made objects of design are continually alternating between two poles. One is austere, clean, logical, functional, and geometric by nature (represented by classicism, neoclassicism, and modernism); the other is free, emotional, sculptural, decorative, and complex in nature (represented by gothic, baroque, and even in some ways post-modernism). After an era in which one paradigm dominates, there follows a paradigm shift towards the other (fig. 2).



2. THE COMPLEXITY OF DEFINING CYCLICAL EVOLUTION OF MAN-MADE CREATIVE OBJECTS



1. A TYPICAL S-CURVE SHOWING TECHNOLOGICAL PROGRESS OF OF NEW PRODUCT INTRODUCTION (BASED ON SIMON WARDLEY, 2014)



3. ROGERS' PRODUCT LIFECYCLE (BLUE) AND DIFFUSION (RED) CURVES

Bearing in mind Mark Twain's quote above, the cycle between these paradigms is never repetitious. Society changes, technology advances, styles and art movements come and go. We are speaking here about a similar principle of things, not often in actually similar things (neoclassical architecture is an exception, as the name implies). The many parallel red tracks in figure 2 represent the complexity of the cyclical process in art and design.

The terms "timeless" (referring to design classics) and "retro" appear in the diagram. I will discuss them in sections 3 and 4 of this chapter.

The Product's Lifespan tenet

Often termed "product life cycle" (personally I prefer the term "product lifespan" because it denotes a distinct beginning and an eventual end), this tenet deals with the growth and evolution over time of a specific product made by a certain company, from the moment of its introduction to the market until the product becomes obsolete and is taken off the market. That is the way marketing people understand this term. Engineers and designers will include in the lifespan a preceding time to market—stages in which the product is conceptualized, designed, tested, and approved for mass production.

Everett Rogers introduced in 1962 the theory "diffusion of innovations," which seeks to explain how, why, and at what rate new ideas and technology spread through cultures. He explained diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system. Rogers identified 5 stages of diffusion: knowledge, persuasion, decision, implementation, and confirmation.

A lifespan of a product is measured by public acceptance (as reflected by sales) over time. It may take a form of an S-curve in certain products (a new toothpaste for example) with a slow beginning, then a noticeable growth and eventually leveling off when sales reach market saturation. Other products follow a bell curve where sales decline rather than level off due to eventual loss of public interest, introduction of competing products or innovative technology, or due to social change. In marketing terms the stages of the bell curve are referred to as the market introduction stage, the growth stage, the maturity stage, and the saturation or decline stage (fig. 3).

As we are dealing with form development, the definition of a product's lifespan will be elastic to some degree, taking into account three related factors: (A) what we mean by product, (B) the stages by which the public accepts a product, and (C) the introduction of form modifications in the course of the product's lifespan.

(A) The term "product" may refer here to either a specific product model (e.g. Microsoft's Zune portable media device), or to all products belonging to a certain group or family (e.g. portable telephones or 35mm cameras), or even to a popular trend (e.g. military looking products, retro products). I agree that the term "trend" is quite ephemeral. I may add that in most cases a trend remains in vogue for a relatively short time; thus, trend-based products usually have a limited lifespan with no extension. Toy fads are good examples of trends.

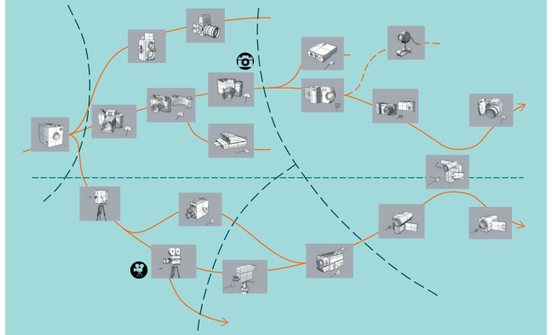
(B) Everett Rogers also introduced the concept of product acceptance by the public. He divided the public into five groups placed along the time axis of a new product adoption, listed below (see also fig. 3, in red).

CASE STUDY 1

The Camera Family

I chose as the first case study a case where a very clear-cut evolutionary development takes place. An evolution into two distinct family branches presents a good example of separation according to the component geometry tenet, and the evolutionary route itself demonstrates divergence and then convergence of form. The changes in form along the way follow closely the rule of continuation but differentiation.

Form evolution of the camera family



SEE ENLARGED DIAGRAM ON PAGE 97

Highlights

This section tackles a typical evolutionary pattern of two family lines branching out from a common ancestor: the early camera cube form.

The stills camera branch and the movie camera branch are defined by a different optical axis relative to the camera's body: perpendicular to the largest face in stills cameras and perpendicular to the smallest, narrowest face in movie cameras.

The third possible optical axis, perpendicular to the intermediary narrow face, was seldom used in cameras. If used, it was usually to define a new or totally different camera technology. Most third optical axis cameras failed to be accepted by the public.

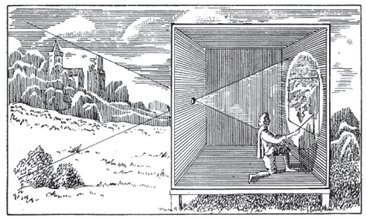
The evolution of cameras changed profoundly when image-capturing technology shifted from chemical media to analog-electronic media, and then again to digital media. In spite of becoming essentially computerized gadgets, cameras adhere to the optical devices' visual traits.

In each step in the evolution of the camera family the newer device tried to differentiate itself from the previous one, indicating visually where the difference lies, while continuing with the family's archetype identity.

In spite of the fact that both contemporary digital stills cameras and digital movie cameras use the same technology and can incorporate the other's feature to a degree; they did not merge into an integrated family line. Each separate branch continues to visually identify itself as different from the other line.

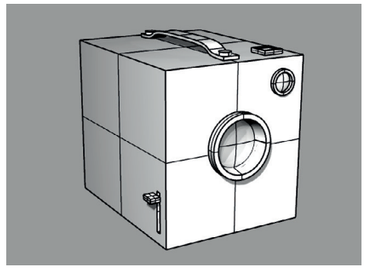
As media communicators (smartphones and tablets) become more popular means of shooting pictures and video on the go, the camera family loses ground in small cameras and concentrates on professional cameras, embracing the familiar visual traits of past professional cameras: complex, large lenses and the ever-present black color.

The stills camera



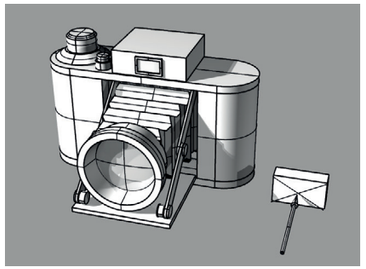
1. THE CAMERA OBSCURA

The first cameras of the late 19th century were basically cubical boxes with a capped lens, with no main visual axis or face. As the name of the product suggests—*camera* means "room" in Italian—it is a scaled down version of the Renaissance camera obscura, which was an actual room with a small hole on one wall that projected an inverted image onto the opposite wall (fig. 1). Not surprisingly, early cameras were analogous to scaled-down rooms, in both shape and proportion. That type of camera was commonly named "box camera," which in taxonomic terms relates the camera form to rooms and boxes. The Kodak box camera of 1887 (fig. 2) was the first really portable popular camera that imprinted the black boxy camera image in the public eye and mind.

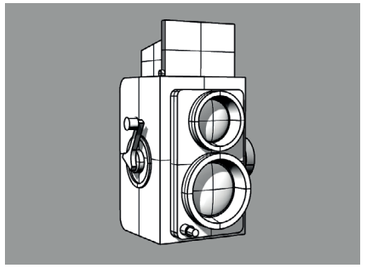


2. THE POPULAR BOX CAMERA OF THE EARLY 20TH CENTURY

Optical innovations eventually improved the camera's portability and focus: bellows (fig.3) and the viewfinder lens of the Rolleiflex camera of the late 1930s (fig. 4). The folding bellows camera set the visual rule on how an ideal portable camera should look—a flattened, non-equal cuboid with its main plain perpendicular to the optical (narrow) axis.

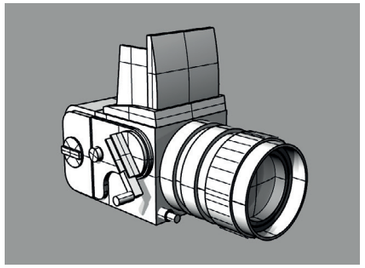


3. THE FOLDING BELLOWS REDUCED THE SIZE OF THE LENS, LEADING TO A FLATTENED FORM



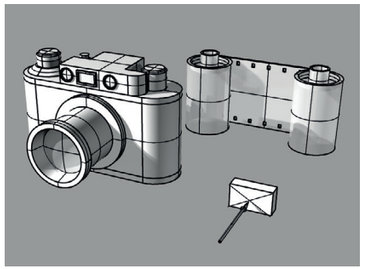
4. THE ROLLEIFLEX HAD A SOPHISTICATED VIEWFINDER AND ASSUMED A VERTICAL BOX FORM

In contrast to the common flat camera form, the elongated square cross-section form of the Rolleiflex camera was retained in the later large format (6X6) professional cameras, such as the classical Hasselblad, introduced in 1948 (fig. 5). The Hasselblad—an icon in itself, immortalized as the camera taken by astronauts to the Moon—held to the same proportions of the Rolleiflex, but with the lens placed on the small square face, and with a protruding viewing hood on top.



5. THE HASSELBLAD HORIZONTAL FORM PUT EMPHASIS ON THE LENS

The first modern-looking camera, the German-made *Leica*, with its superb optics that legitimized, once and for all, the smaller 35mm film format, appeared in 1930 and established the visual form of 35mm cameras to come. In this classical camera shape the lens was located in the middle of the major flat face (i.e. the face parallel to the film plane) of the camera, and the two film advance knobs echoed the location of the roll film inside (fig. 6). From here on, the 35mm camera adhered to a symmetrical form, as seen in the immortalized camera icon (fig. 7).



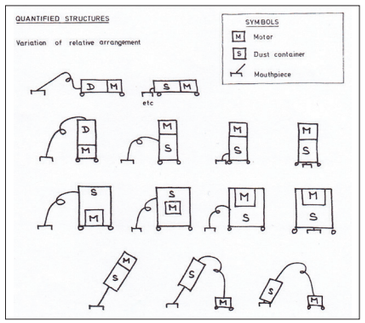
6. THE 35MM CAMERA FORM ECHOED THE SHAPE OF THE ROLL FILM INSIDE. THE SMALL ARROW AND BOX INDICATE OPTICAL AXIS ORIENTATION

7. THE IMMORTALIZED CAMERA ICON

CASE STUDY 8

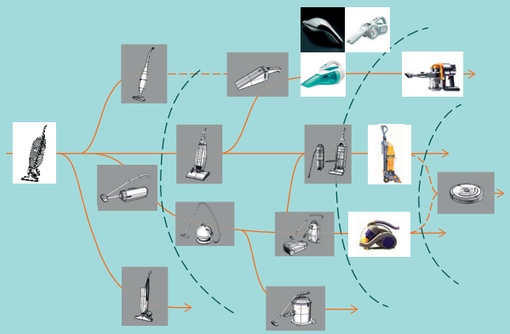
Vacuum Cleaners

Compared to most product lines' typical visual configurations, vacuum cleaners have many varieties as the technology of dirt suction and collection may be successfully accomplished by rather different engineering component configurations, as Erskin Tjalve pointed out years ago in his book *A Short Course in Industrial Design* (fig. 1). We easily recognize them for what they are, from the small cordless DustBuster, to the much larger size and form of industrial wet-and-dry vacuum cleaners, and to the exposed vortex innards of the Dyson line. We will investigate here why that occurs.



1. TJALVE'S STUDY OF FEASIBLE VACUUM CLEANER CONFIGURATIONS

Form evolution of vacuum cleaners



SEE ENLARGED DIAGRAM ON PAGE 161

Highlights

The vacuum cleaner family has a linear functional configuration composed of separate components. Most key components can be rearranged in diverse orders, allowing for considerable flexibility in configuration and easy branching into separate lines.

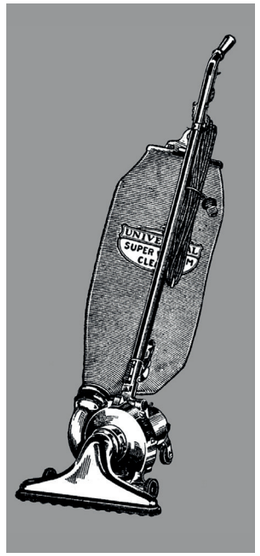
They present three human-operated branches: upright, canister, and handheld. A separate recent branch is robotics.

Even with a wide breadth of form configuration, vacuum cleaners are easy to recognize visually, less by overall form and more by identifying key visual features: distinctive flexible hose, T-shaped suction tube, dust container, and more. Not all features need to be present in the product in order to facilitate the family identify.

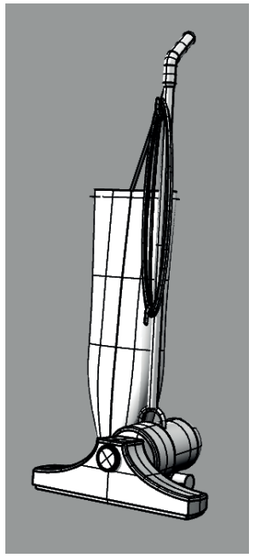
The cordless handheld vacuum cleaner, a late addition to the family, lacks the typical elongated linear arrangement of the family, but here too, in spite of prolific design variations, they are easily recognized.

Contrary to the long-lived tendency of designers to hide engineering complexity from sight, Dyson's emphasis on visually exposing engineering complexity is currently a design leader in the trend to articulating the visual vocabulary of the family.

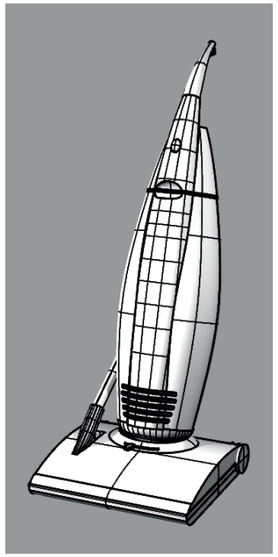
Robotic vacuum cleaners are not common yet. By eliminating most human involvement, we may anticipate a totally different form archetype.



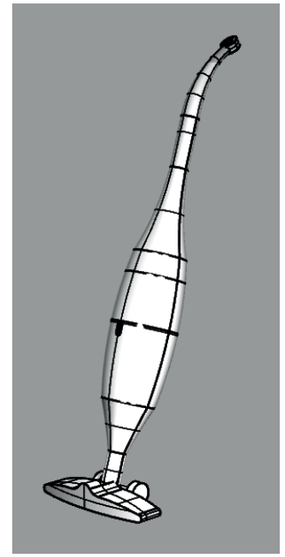
2. EARLY VACUUM CLEANERS HAD THE SAME BASIC FORM. THE LOGO ON THE BAG IDENTIFIED THE MAKER



3. PROFESSIONAL, INSTITUTIONAL UPRIGHT VACUUM CLEANER



4. A TYPICAL AMERICAN-MADE UPRIGHT VACUUM CLEANER



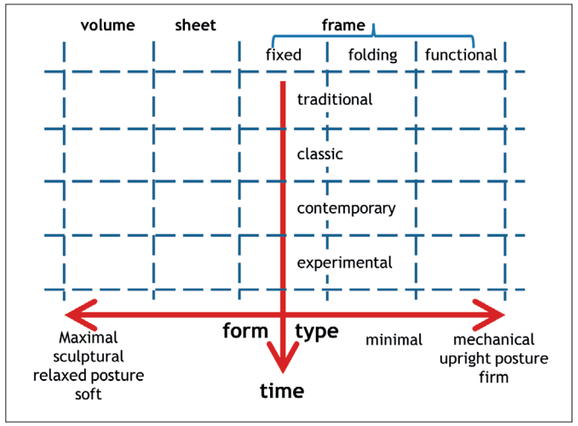
5. A LIGHT-DUTY UPRIGHT DEDICATED TO CLEANING STAIRS

Early vacuum cleaners

In the beginning of the 20th century, inventors in both the United Kingdom and the United States registered patents for early, motorized vacuum cleaners. Their aim was of course to ease manual sweeping chores and replace the broom and dustpan and the manual carpet sweeper. As the cleaning environment did not change—the need being to reach the floor, and nooks and crevices—it was practical to carry on the basic broom structure: a long pole and a short T at its lower end. The suction orifice, made of cast aluminum, hung back to the wooden broom neck shape. Stubbles at the suction end replaced the broom's bristles. The electric suction fan was attached externally behind the suction device. The Inventor of the first practical vacuum cleaner in 1907, James Murray Spangler, turned his wife's pillowcase into a dust bag, initiating several generations of the dust bag, be it made of fabric or paper, as a sign of dust collection (fig. 2).

The formless bag did not hide the previous broomstick, probably because the bag seemed to be external and insubstantial (consider the grass collector on lawn mowers). In fact, all the new elements were riding on the previous broomstick, now a metal shaft. The added weight of these contraptions dictated wheels to facilitate easy movement on floor or rug. The wheels were quite small and inconspicuous then, but they remained as long lasting cues in the component vocabulary for the family. The slight bending of the broomstick end at the top, though relatively minor, was carried over into future vacuum cleaners.

It is surprising that the components-on-a-pole approach, giving the impression of an archaic engineering prototype stage, continued for several decades. Even today you may find institutional vacuum cleaners in the hands of hotel cleaning maids that devoutly adhere to that form configuration, including the old-fashioned fabric dust bag and cast aluminum nozzle (fig. 3). That persistent traditional look, which is often acknowledged as timelessly professional, is similar in its lingering aura of the traditional Kitchen-aid professional mixer.



11. CHAIR CLASSIFICATION MATRIX

not take into account three variants of chair structure: the static (fixed) frame chair, the folding frame chair and the adjustable frame chair. The latter is ubiquitous in the office environment, so I prefer to use the term "functional" rather than "adjustable." Now, the proposed range is not just from the maximal to the minimal, it also ranges from the sculptural to the functional and from the relaxed posture to the upright posture.

So far I was quite technical and did not take into account any cultural variables in this classification. So I will base the cultural range on Roger's diffusion of innovation theory, ranging from the traditional, through the classical, the modern, and to the avant-garde (I prefer the use of the term "experimental"). The grouping of the form and function classification axis and the cultural acceptance axis creates a classification matrix (fig. 11).

Looking at the diagram at the end of this chapter you will notice that there is a usually smooth form transition in the horizontal rows. I placed representative chair images more as indicative visual images and not as a collection of best design icons. This is particularly noticed in the classic row since I placed there very common (literally) chairs next to icons of design. Certain chairs cannot be pigeonholed in one specific classification. They may belong to two categories. Admittedly, there will be certain chair designs that will resist any classification at all, especially the experimental ones. The design world is not and should not be strictly rational.

Now let me delve into the visual characteristic of each form type category.

Volume chairs

Chairs in this category are by definition massive, as they fill the space between the floor and the human body and even more. Massive chairs came about early in Homo sapiens' evolution: a suitable rock or tree stump. In historical times, the volume component was usually ancillary to structure, mainly to cushion the chair's seat and armrests. From the Victorian era onwards, increasingly informal and comfortable living prodded upholstery to eventually cover the whole chair. The reclining posture called for an ottoman (fig. 12).

Volume chairs usually hide an internal support structure; most couches are built around a rough wooden frame, others may have rigid foam fillings, and some, like beanbags, have no support at all. As the internal structure or filling is not visually apparent, we deal in visual terms with a volume—a mass—even if we are aware that the cover fabric is only skin-deep. An egg looks like a rock until the eggshell is ruptured to reveal a shell. Lacking a structural form commitment, volume chairs may take almost any shape design. Most tend to overstate their volume by surrounding the body. Volume chairs are large, sculptural, and soft, at least in visual terms, and less portable (fig. 13).

12. A TYPICAL COUCH AND OTTOMAN

13. DANIEL MICHALIK RECYCLED CORK CHILDREN CHAIR (2004); AND RON ARAD BIG SOFT EASY CHAIR (2001)

Sheet chairs

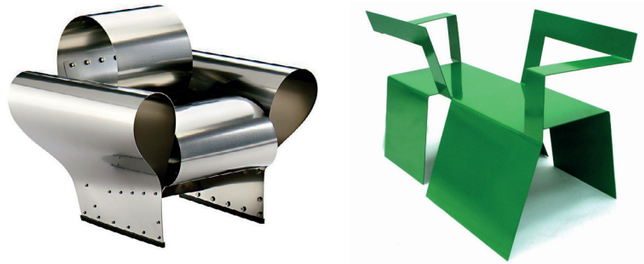
Chair-as-skin as a design concept is a relative newcomer. Structural strength based on bending and folding sheet material was realized only when technology was ready. The Charles Eames 1955 lounge chair reveals a bent plywood sheet structure but it is conceptually still a frame type chair. Alvar Aalto, Charles Eames, and Frank Gehry are renowned for their exploration in forming sheets of plywood (fig. 14).

Ron Arad dropped the pre-forming of material to shape, and instead experimented in twisting and riveting exposed sheet metal. Ana Linares suggests a sheet metal folding approach (fig. 15).

Even earlier, in the 1960s, fiberglass shells and, later, plastic heat-forming and molding allowed for a wide range of soft-curved chair shells, but most of them were externally supported by a metal frame—somewhere between sheet and frame classifications. In these cases, the frame tends to be visually minimal as in the handkerchief type chairs here (fig. 16).

Ron Arad also carried out several innovative experiments with rigid, preformed plastic skins. I chose to show his lacquered plywood three-skin chair, which has a convincing formed-plastic feeling. The purest sheet plastic chair is probably the iconic molded chair by Verner Panton, produced in 1960 (fig. 17).

14. EARLY BENT PLYWOOD CHAIRS BY ALVAR AALTO (1943); AND A CONTEMPORARY CROSS CHECK CHAIR BY FRANK GEHRY



16. THOMAS PEDERSEN STINGRAY CHAIR; AND ARMCHAIR BY JASON LIU BASED ON HANDKERCHIEF CHAIR BY MASSIMO & LELLA VIGNELLI

15. RON ARAD'S WELL TEMPERED CHAIR (1986); AND ANA LINARES' CONVERSATION CHAIR

17. MOLDED PLASTIC CHAIR BY VERNER PANTON (1967); AND RON ARAD'S THREE SKIN CHAIR

or tea or soup. Since this indifference reflects upon other preparation products, I will devote a later section to hot water makers.

Because I will focus my discussion on the evolution of key preparation tools, I will ignore most of the auxiliary paraphernalia involved in the process, such as coffee roasters, grinders, milk foam makers, and tea strainers.

Coffee preparation

> **Coffee is a language in itself.**
>
> **Jackie Chan**, a Chinese film actor and martial artist/comedian

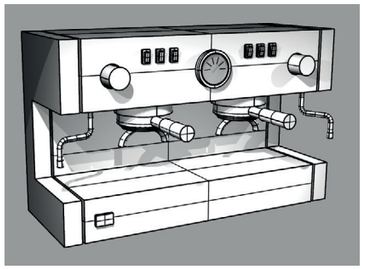
Coffee preparation is the process of turning coffee beans into a beverage. In the process, raw coffee beans are roasted, the roasted coffee beans are ground, the ground coffee is mixed with hot water for a certain time (brewing), and finally the liquid coffee is separated from the used grounds. Coffee is usually brewed immediately before drinking.
There are four ways of brewing coffee which greatly affect the coffee preparation product: boiling, gravitational feed (drip brewing, filter brewing), pressurized percolation (espresso), and infusion (steeping, French press).

4. TRADITIONAL TURKISH IBRIK AND CONTEMPORARY MIDDLE EASTERN FINJAN

Boiling was the universal method used for brewing coffee until the 1930s and is still used in some places, notably Middle Eastern countries, where the ground coffee is purposefully not separated from the water and remains in the drinking cup. This method, named "Turkish coffee," uses a kettle called *ibrik* or *finjan* that is heated over a stove. The traditional *ibrik* has an elaborately sculptured Middle Eastern image (fig. 4). Its contemporary version looks almost like a regular cooking pot, the ritual is in the pouring gesture.
In the infusion or steeping method of coffee brewing, a plunger inside the pot is pushed down several minutes after the hot water was poured in, separating the coffee from the grind. This method was common in France, named *Cafetière* or "French press." The traditional *Cafetière* and its Bodum modern design version are quite the same (fig. 5).

5. A TRADITIONAL FRENCH PRESS; AND A MODERN BODUM *CAFETIÈRE*

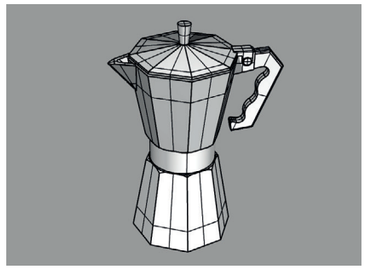
6. THE ORIGINAL BEZZERA ESPRESSO MACHINE, 1905 (LEFT); AND A RETRO-INSPIRED, LEVER-OPERATED MACHINE (RIGHT), 2014



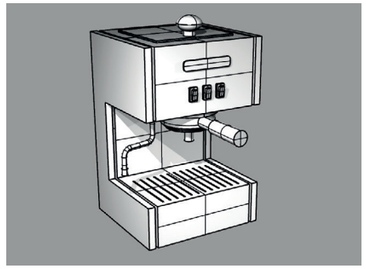
7. ARCHETYPAL FORM OF COFFEEHOUSE ESPRESSO MACHINE

Boiling pots and infusion pots owe their form to traditional jugs. The infusion pot looks modern as its plunger action entails a clean cylindrical form. Boiling and infusion had a limited form evolution, while other brewing methods—pressurized percolation (to simplify I will use the term espresso) and drip-filter coffee makers—evolved significantly.

Espresso originated in Italy, but since the 1950s, it has become popular all over the world. It is made by forcing boiling hot water under high pressure through a lightly packed matrix, called a "puck," of finely ground coffee. It is one of the most concentrated forms of coffee regularly consumed, with a distinctive flavor provided by crema, a layer of foam floating on the surface, which is produced by the high pressure. Espresso is the basis for many coffee drinks. The traditional communal steam espresso machine of 1905, invented by the Italian inventor Luigi Bezzera, was really an awesome machine in the tradition of Victorian era steam engines, with many dials and levers (fig. 6). Note the sculpture's "helmet" top, which represents the presence of pressurized steam. The successors of the Bezzera machine from the 1940s onwards, the ones we are most familiar with in coffee houses, changed form from a vertical axis sculpture to an efficient, horizontal design (with a top balcony for storing cups, and featuring a control panel, an intermediate consumables handling tier, portafilter handles, foam tubes, and a base that doubles as a drip collector). This rectilinear, horizontally extruded "C" design represents the classic espresso machine (fig. 7). Some models may have a rounded version of the basic form. Aside from technological improvements that eliminated long pressure levers, the basic form hardly changed over time. Interestingly, the machine's blank rear panel is all customers see in a coffeehouse environment, perhaps with a distinct logo and the telltale cups on top. Still, our recognition lies with the form always facing the barista.



8. MOKA POT, ITALIAN HOME ESPRESSO MAKER

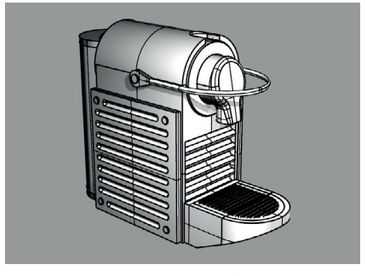


9. THE ARCHETYPAL FORM RELEGATED TO DOMESTIC USE

The moka pot, the domestic Italian stovetop espresso maker (fig. 8), has a form absolutely unrelated to the commercial machine. Its form is based on traditional pots and jugs. Its hourglass form hints at how it works, the bottom cone is a pressure cooker, the waist is the coffee puck location, and the top collects the coffee forced up by pressure. In spite of the hourglass body form, the traditional faceted octagonal shape and muscular handle are masculine, hinting at pent up pressure inside.

As expected, the next version of home espresso machines adopted a compact form of the commercial one, with only one brewing station and a topmost water compartment (fig. 9). As in most home appliances, brands (almost all Italian) tried to differentiate their designs, but principles of form did not change much from the classic archetype form. In fact, the home espresso machines adhered adamantly to the complex "machine" look, as if espresso brewing were a secret, macho art that relates somehow to operating a steam locomotive.

10. DELONGHI HIGH-END ESPRESSO MACHINES



11. NESPRESSO—FORM AND LIFESTYLE PROMOTER

Only with the spread of electronic controls did espresso brewing progress into the realm of pushbutton operation. The high-end DeLonghi espresso machines (fig. 10) are a good example. In it, mechanical brewing operations are hidden, including the brave omission of the portafilter and its signifier handle: the language of all past espresso machines. Still, it manages to retain the "expert" aura. The rule of continuation but differentiation applies here with the machine proportions based on a cube. The traditional three-tier horizontal division of form is still present, but a new vertical division into three segments is introduced. The central intersection of the horizontal and vertical is carved in, signifying the place for the coffee cup, a cue taken from coin operated automats. But in order not to be confused with similar designs of hot water dispensers, a milk container is added to the form. The increased prominence of the vertical arrangement will be echoed in many later automated coffee makers.

The next form evolution came with the introduction of coffee capsules that eliminated once and for all the cleaning of spent coffee grinds. In my opinion, the Nespresso brand line (fig. 11) epitomizes the modern cultural image of espresso machines: elegance replacing what was formerly complex. Controls, even push buttons, are reduced to a minimum. Turning one lever to start the process commemorates past pressure levers. Even that single reminder disappeared from subsequent models.

The Nespresso models incorporate several formal changes. The cube form came to be narrow, tall, and deep, providing a smaller footprint on the kitchen counter. Two previously hidden internal elements are exposed: a transparent cylindrical water container at the back and a horizontal barrel top that suggests an internal pressure piston. The coffee spout reflecting past portafilters is placed prominently in

Form evolution of coffee & tea preparation