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PERCEPTION-ORIENTED PRODUCT DESIGN AS A DESIGN CHALLENGE

THOMAS GATZKY
Otto von Guericke University Magdeburg
Faculty of Mechanical Engineering
Research and Teaching Area Industrial Design
39106 Magdeburg, Universitätsplatz
thomas.gatzky@ovgu.de

1. Introduction

Product development focuses on creating a geometric-material entirety. Several engineering disciplines as well as industrial design contribute to reaching this objective. Depending on the specific profession and perspective, the term geometric-material entirety may refer to the form of a component, the form of an assembly or even the complex shape of a product.

Both engineers and industrial designers share the common goal of producing a product's geometric-material entirety. Common and interdisciplinary challenges clearly manifest themselves in form- and shape-finding processes which make up a large part of the product development process.

Designing means creating order.

If an engineer is aware of the aim of creating order as part of a form- and shape-finding process and if he or she understands how order in terms of design can be created, he or she will be open to the decisions made by a product designer. Principal findings and recommendations can even be derived for development work in engineering design which help reach and advance objectives pursued in product design. For this reason it is a key factor in the form- and shape-finding process to identify design problems from an aesthetic point of view in order to facilitate a cooperative and integrative approach followed by both engineers and industrial designers in product development.

Design aspects in terms of colour, material and surface aesthetics are indispensable to product design development as they are always associated with form- and shape-finding processes. This article focuses on the categories of form and shape because this is the area where most links to engineering disciplines exist. Furthermore, it is here where particular importance is attached to form and shape perception as an element of product perception.

1.1. Structure – form – shape

Drafting and designing are processes in the course of which an immaterial state turns into a geometric-material state after having gone through many development steps. Fresh ideas, initial sketches, abstract functional and use structures describe the product's future features, which however, cannot yet be experienced sensorially. They are the basis for initial form and shape concepts which in the further development process become more clearly defined, holistic and perceptible.

Technical, ergonomic and design objectives fuel the progressing form and shape-finding process.

In general, the development of a geometric-material product entirety follows the example shown in Figure 1.

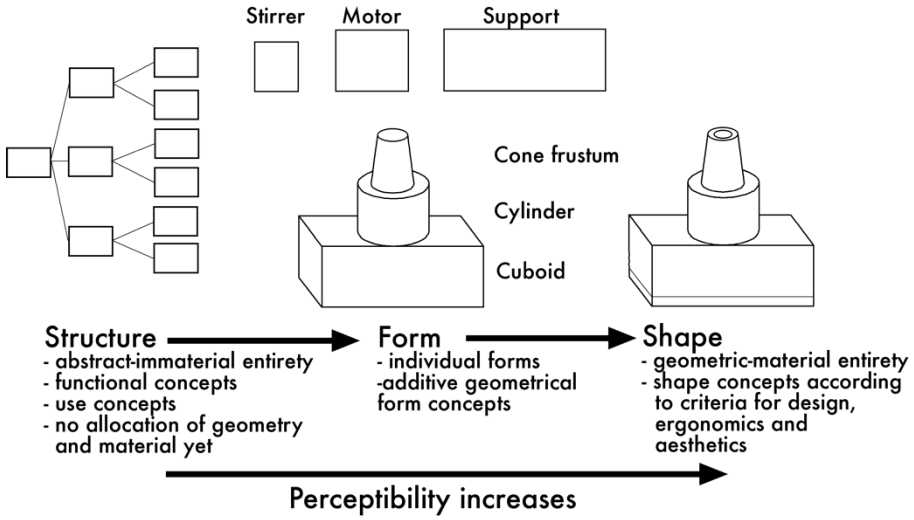


Figure 1: Transition from structure to shape [3]

Furthermore, the transition from immateriality to the geometric-material state of form and shape is also a transition from immaterial abstraction to perceptibility. From this stage on, concepts of form and shape can be sensorially experienced and are consequently subject to an aesthetical analysis and evaluation. Interestingly, it is not only the continuously changing product shape that can be experienced sensorially, but also its representation in the form of draft designs, engineering structural drawings and models. Various visualisation techniques applied in the early phases of product development aim at improving the perceptibility of design results.

2. Human-product interaction or the fundamental aesthetic problem

Until the 19th century, the word *aesthetics* (derived from the Greek *aisthetikos* meaning "aesthetic, sensitive, sentient") was often equated in traditional classical art with the doctrine of beauty. Works of painting, sculpture, music, theatre and literature were in the focus of aesthetics.

Traditionally, everyday products were not evaluated according to the criteria of classical aesthetics. However, various reform movements put the focus of aesthetic contemplation increasingly on normal life. The new unity of art and technology as propagated by the *Bauhaus Dessau* resulted in a new acceptance of industrially manufactured products.

The concept of beauty was extended to include industrially manufactured products, which, however, required a new approach to aesthetics. From this time on, aesthetics was defined as the theory and philosophy of sensory perception in arts, design, philosophy and science.

Hence the aesthetic value of a product is not determined by such terms as "beautiful" and "ugly", but by the product's sensory properties and/or meaningfulness. All questions of product perception, particularly the product's overall shape and all usage operations, are connected with this notion.

Humans perceive products through their sensory organs (receptors). On the product side this requires *perception stimuli* such as form, colour, material and surfaces. When processing such stimuli, humans respond by exhibiting *behavioural reactions* in the form of experiences, actions and evaluations.

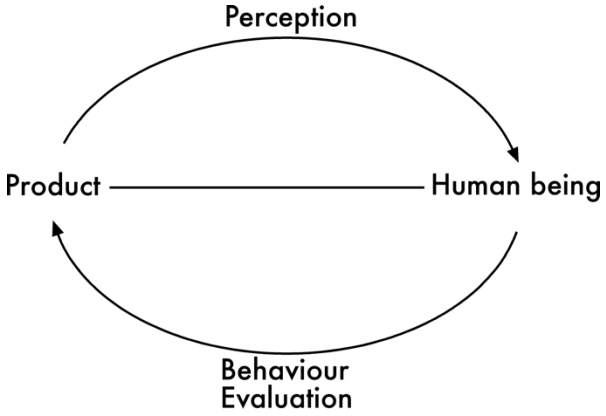


Figure 2: Human-product interaction as a basic aesthetic problem [3]

However, perception also means to understand content and meaning.

Behaviour can be described as a human being's response to what he or she has perceived. Observing or operating something are important actions which may be experienced in a special way. Experiences and actions prompt the user to make judgements and evaluations. Affirmation or rejection as well as verbal judgements such as "I like it" or "I don't like it" often complete a man-product interaction.

The degree of fulfilment of a human-product interaction always depends on the relationship between perception and behaviour. Therefore, it makes sense to postulate perception-oriented design as an objective of designing. With regard to the design process, satisfying this objective requires dealing with the stimuli of perception. The process of finding an overall product design (shape) that does not only meet technical but also aesthetic criteria should be highlighted in this context. Perception-oriented design also means to consider those requirements that result from the physiology and psychology of human perception as well as from an individual's experiences or as a result of his or her external environment. This also includes the elements used in designing products with regard to their appearance.

Perception-oriented design as a design objective and precondition means to design products so that a person can perceive such products in a way that suits his or her senses and intellectual perception.

2.1. Perception

Humans can perceive their environment in several ways.

Approximately 60–80% of all environmental stimuli are visually perceived. For this reason *visual perception* is of utmost importance for man-product interactions and it substantiates the dominance of visual design aspects in industrial design. Basic interrelations are shown in Figure 2.

Perception means seeing and understanding.

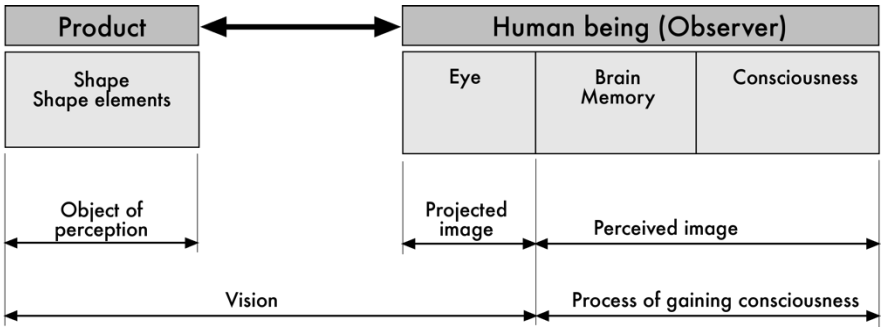


Figure 3: Human-product interaction as a process of visual perception [3]

A human being in his or her role as an observer recognises the product. The shape of the product and its design elements are prerequisites for perception. The shape of the product and its design elements are perceived visually and processed as a projected image in the eye, followed by a process of cognition which results in a perception image.

Therefore, we must distinguish between two phases of perception:

1st phase: The development of a projected image is an objective, physico-chemical process which is equally developed in almost all human beings.

2nd phase: The development of a perceived image is a subjective process that depends on the observer's individual memories, experiences and value concepts. Furthermore, the observer's subjectivity is also influenced by his or her sociocultural environment that particularly defines value concepts and norms.

The user perceives things in a subjective way and behaves accordingly.

Product design is part of a product development process focusing mainly on the manufacture of mass products that are to satisfy the needs of larger groups of buyers and users. However, large groups of buyers and users always consist of individuals. Consequently, it is a special challenge to develop mass products that are capable of satisfying individual needs. This is the reason why the product development process necessitates an intensive analysis of user requirements.

2.2. Perception, behaviour and use

Humans use products in order to organise their lives and satisfy their needs. It is evident that the design quality of products has a decisive influence on the quality of life and its meaningfulness. Use scenarios and/or use processes determine the active man-product

interaction. Therefore, it is obvious that drafting and designing take precedence in the process of planning a future object's use both intellectually and physically and of turning it into a model.

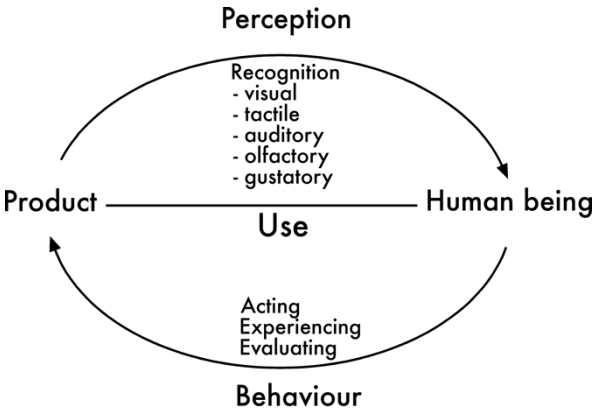


Figure 4: General interrelation between perception, behaviour and use [3]

The way a product is used illustrates the interrelation between perception, behaviour and use. The object transmits perception stimuli which are received and processed by a person who then acts upon them. Sometimes this may be a haptic response (pushing a pushbutton) or just an unconscious emotion (acceptance), often connected with an evaluation (verbal judgement).

3. Perception-oriented design as a design challenge

The primary objective of industrial design is to create a state that can be described as the quality of appropriate sense and intellectual perception *(Wahrnehmungsgerechtheit*).

Drafting and design processes help objectify immaterial concepts (ideas, thoughts) through drawings and physical models by making them a truly sensory experience. On this basis, the following basic statement with regard to designing can be made:

Designing products according to aesthetic criteria is about perceiving and experiencing harmony, a sense of well being and grace, but also contrasts and tensions. It is through the process of use that the user is sensorially stimulated and perceives it as a personal experience.

"Dimensioning" this sensory stimulation is a decisive problem in designing. It is determined by the relationship between perception and behaviour. Various creative measures are applied in the design process to develop and stimulate a user's future behaviour and experience of using a product.

3.1. The use scenario

Now the question arises of how the process of use can be described in greater detail. What does it mean to use a product? It is the aim of this section to identify various areas of

design and to analyse the requirements that make it possible to evaluate to what degree a product has the quality of being perception-oriented.

At the beginning of every design process, the designer faces the following questions:

- How should the product be used by a future user?
- What form/shape should the product have?
- What are the correct or appropriate sequences of handling and operation?

The above and similar questions result in designing tasks that determine future use scenarios. The use scenario is determined by the entirety of all operation and aesthetic requirements.

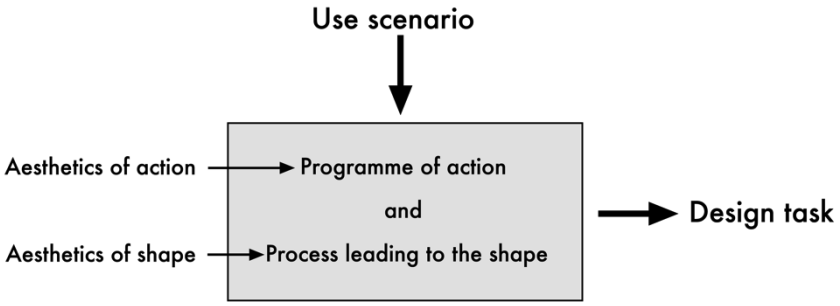


Figure 5: The use scenario as a design challenge [3]

3.1.1. Aesthetics of action

Operation and use determine product perception because the user experiences and evaluates specific operation processes. Frequently, the quality of these operations decides about a product's value.

Aesthetics of action is a sensory and meaningful element of design tailored to meet human needs. Where design is expected to be in line with a person's sense and intellectual perception it deals with performing, integrating and developing situations for concrete action. Criteria that can be designed and evaluated include, in particular, action competence and control.

Perception-oriented design is characterised by the following principles that reflect the relationship between perception and behaviour.

Simplicity: Appropriate cost/benefit ratio. One of the most important quality criteria is the appropriateness of the design (shape) in relation to the object's purpose, its use value and its value as such. Simplicity includes features such as honesty, authenticity, clarity and good organisation. Complexity (or overloading) is often experienced as confusing, disorienting and inappropriate.

Clarity: Quick and unambiguous recognition of a design situation facilitates controlled and reliable operation.

Visibility: Easily visible "signals" (information) are a prerequisite for safe use. For example, a coffee cup should have a reasonably sized handle to not only allow big fingers to grip it easily but above all to facilitate recognition of the cup's purpose. If these signals are not transmitted, irritation and inappropriate use may be the result.

Feedback: Both important signals for action but also the relevant feedback must be perceivable, preferably in a visible form. Any feedback should be given immediately after

the relevant action. If this feedback is not given or comes too late, the user does not know whether his or her action was correct and completed successfully.

Mapping: Mapping means that the functionality of acting and the result thereof are meaningful. When function, action and actual execution are made visible it is easier for the user to recognise and understand various relationships. Analogies and compatibilities with known experiences help the user to execute various operations. A typical example is the waste-paper basket or trashcan on the user interface ("desk top") of a computer. The design follows the artefacts and organisation of a real office. The image of a waste-paper basket on the desktop provides an abstraction of the "delete" function. The virtual processes of disposing, throwing something into a waste-paper basket and picking it up again are analogies to a waste-paper basket in the real world. Even though data on a computer are disposed of in a different way than normal garbage, the user is familiar with this process through the image of the waste-paper basket, though virtually.

In this connection the close interrelation of ergonomic and aesthetic design aspects in product design should be underlined.

Schürer referred to the reciprocity of ergonomics and design by stating:

"While ergonomics should be understood as a component of design, aesthetics should be seen as an element of ergonomics. However, aesthetics should not be understood as associative aesthetics, i.e., aesthetically pleasing, but as aesthetics related to the course of action, in other words as a function guiding action. On the one hand, it influences the process of how an object is experienced, on the other hand it has an influence on the response to these phenomena and finally on how actions are to be executed. Experiencing, behaving and acting are basic human dispositions. They cannot only be expressed by appropriately designed elements for executing an action, i.e., hardware-ergonomic design. On the contrary, they are essentially influenced by the meaningful design, i.e., the software-ergonomic design of elements related to the course of action." [6]

The progressive creative drafting of use scenarios is a real opportunity to overcome the divide between design and ergonomics.

3.1.2. Aesthetics of shape

Perception-oriented design always aims at finding a shape presenting a unity of form, colour, material and surface. As stated at the beginning, form is of prime importance with regard to product perception.

For this reason, the process of developing a form and shape in line with a person's sense and intellectual perception is key to the design process.

In the following section, the fundamentals of form and shape-aesthetical interrelations that support design and evaluation processes in line with sense and intellectual perception will be described.

3.2. Introduction to a theory of form and shape in line with human sense and intellectual perception

The term *theory of form and shape* should be understood as the recognition and application of objective criteria required to allow a person to create a form and shape and to evaluate them according to relevant criteria. As a rule, in engineering, mathematical/geometric descriptions are applicable as a result of technical requirements such as

load, functional performance, manufacture, etc. In product design, these are formal-aesthetic descriptions that are based on aesthetic requirements.

A perception-oriented theory of form and shape can aid the process of understanding and influencing effects on humans by considering how humans perceive features of form and shape.

3.2.1. Fundamentals of perception of form and shape

The most elementary type of perception is the figure-ground relationship.

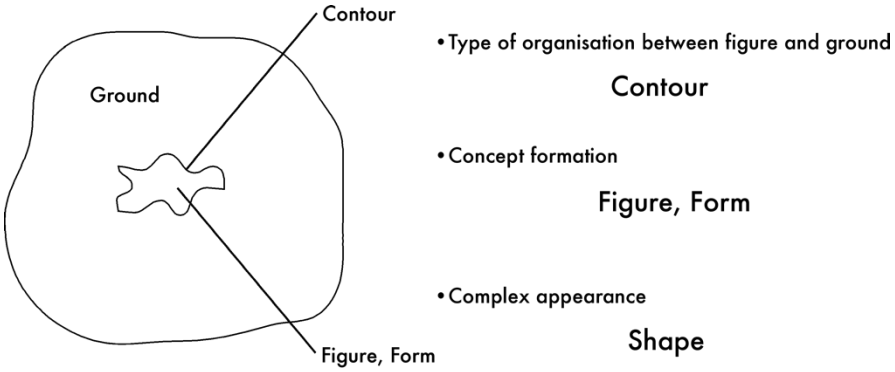


Figure 6: Figure-ground relationship [3]

An outline or contour creates a form, a perceptual grouping, which is in contrast to its surroundings or the background. This is a vital necessity for perceiving and recognising the form. The contour is decisive for identifying the form and determines its meaning/expression. The following example is typical of all contrast phenomena.

A circle has a typical outline whereas a triangle has one that differs from that of the circle. The observer assigns specific terms to these different shapes (here: circle and triangle) helping to distinguish and describe the relevant form. Both result in different perception images, i.e., the circle's effect on the observer differs from that of a triangle. This is the starting point of design knowledge to be applied in the design process.

3.2.2. Form and shape

The following section focuses on the difference between form and shape. This is important because this differentiation is vital to the design process as it facilitates analyses with regard to the results to be achieved in the process of perception.

Form is defined as a coherent single phenomenon. A contour creates an areal form, the shape of the surface creates a spatial form. Developing or creating a form means designing a contour or surface. The shape of the contour and surface determine perception.

The shape of the contour is a precondition for perceiving the areal form. The geometry of the contour determines the expression of the form.

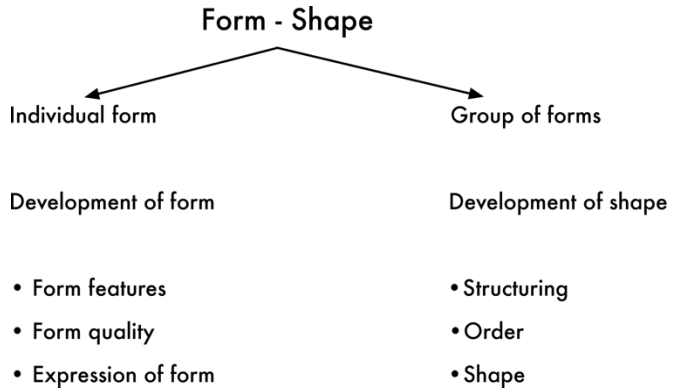


Figure 7: Terms used in the aesthetics of shape [3]

The shape of the surface is a precondition for perceiving the spatial form. The surface geometry determines the expression of the form.

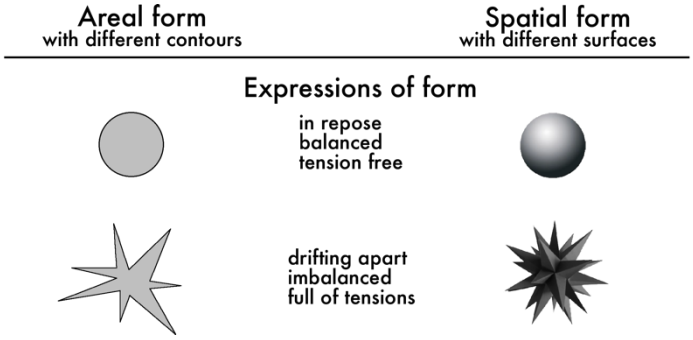


Figure 8: Examples of areal and spatial forms and their different forms of expression

The example given in Figure 8 shows the interrelation between contours and surfaces and their effect on the observer. These are the fundamentals of a perception-oriented theory of form which will be described in greater detail in Section 3.3.

From a design perspective, shape is defined as a group of forms. Developing a shape describes the way in which individual forms are combined to form a shape. The way an object is perceived can be consciously influenced by various design measures such as structuring and arranging.

In terms of their geometric-material characteristics, form and shape are the elements with the strongest impact on perception. Humans experience the most intensive and comprehensive perceptive impressions by perceiving forms and shapes. This is also the reason why creative work in design processes is particularly intense.

At this point the complexity of shape should be highlighted.

A shape is not only a geometric group of forms, but the entirety of the aesthetic elements of form, colour, material and surface and their individual characteristics such as the constellation of the shape elements vis-a-vis each other. It is only then that the shape emerges which is a precondition for complex product perception.

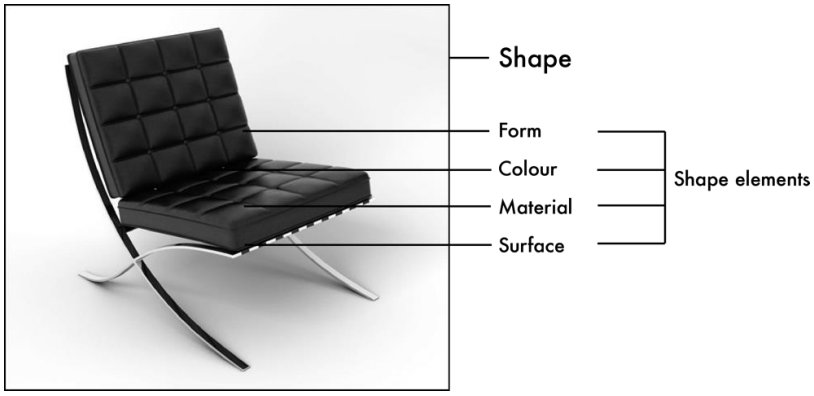


Figure 9: Overall shape
(as exemplified by Ludwig Mies van der Rohe's Barcelona chair, 1929) [3]

Developing a product shape requires dealing with its future situation of perception. The degree of interconnections between the aesthetic elements – described here as overall shape (design) – is of prime importance. This degree has a decisive influence on the perception of the design.

The overall design (shape) results from

- the nature of the shape elements used
- their quantitative use in the product and
- the relationship between the individual and the whole.

Depending on the proportions in the product, two ways of perception are possible: the impression of order or the impression of complexity. Figure 10 shows the impression of order and complexity as exemplified by two watches. This key differentiating factor alone causes different effects.

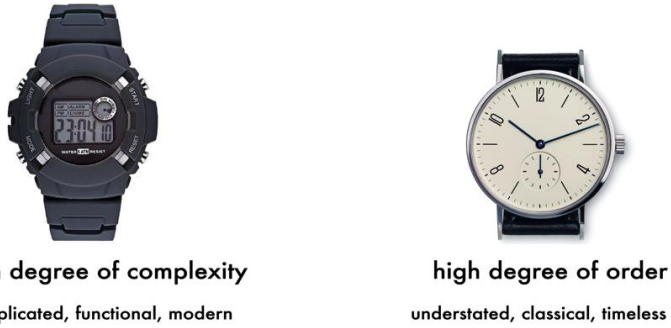


Figure 10: Example of different overall designs producing different effects [3]

Order means:

- low number of shape elements
- low number of arrangement features

Complexity means:

- large number of shape elements
- large number of arrangement features

Order and complexity are the result of a deliberate design process aiming at creating perceivable effects on the user.
Such effects can be, for example:

- simple – complex
- clearly arranged – confusingly complex to chaotic
- expensive – cheap
- old – new
- interesting (affirmation) - uninteresting (indifference)

The effect of order and complexity is also shown in Figure 11.

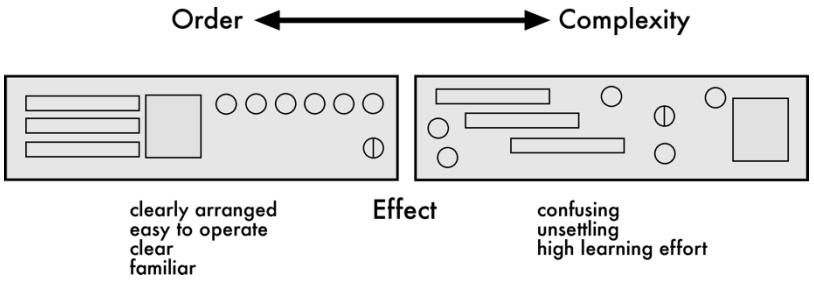


Figure 11: Different states as illustrated by a radio's user interface [3]



Figure 12: Example of the cockpit design of a middle-class car (top image: predecessor model, bottom image: 2013 model)

Figure 12 shows a recent example of a car cockpit design. The analysis focuses only on the design of the control elements. Other design features are not taken into consideration.

In summarising the following can be stated:

Only conscious design processes produce the desired effect.

Figure 13 shows a schematic drawing of two faces made up of identical design elements. Only one of these elements is arranged differently. However, this minor (design) difference causes a tremendous difference in effect.

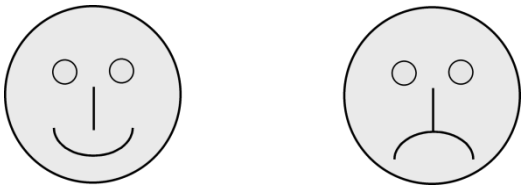


Figure 13: Schematic drawing of two design solutions consisting of identical design elements [3]

3.2.3. Rules of designing

The examples above confirm the interrelation between design and the effect caused in a user. This gives rise to the question of whether there are rules, recommendations and criteria for and examples of perception-oriented design processes. JAKOBY gives a good overview including practical examples of perception-oriented designing [1]. These recommendations are aimed at engineers and designers alike.

In contrast to mathematics, physics and technology, the application of rules does not inevitably lead to good results, i.e., well-designed products. In product design, it is important to continuously examine the resulting effect on the product and compare it with the desired objectives and correct them, if necessary. The rules of design are derived from the properties of the human visual perception system. They follow a set pattern that is almost identically experienced by all human beings. For this reason, these rules can help make designing processes more objective. In principle, all rules go back to the relationship between order and complexity.

For in-depth descriptions and examples see [1].

3.3. Methodical approach to a perception-oriented theory of form

A methodical approach to a perception-oriented theory of form rests on the assumption that human perception of forms is mainly shaped by our perception of forms in nature. Humans are permanently surrounded by archetypal forms in nature. They shape our geometric perception of form and attach relevant interpretations and meanings to them. Therefore, it is only natural to make use of these basic natural forms and apply them to “artificial” man-made forms.

The aim is to create effects on human beings while keeping in mind how we perceive forms.

From an evolutionary perspective, the perception of form can be derived from the perception of nature. To this end, it is evident that natural forms are always the result of processes in compliance with natural laws. The diversity of forms in nature is infinite and cannot be measured by human standards and needs. However, this does not apply to man-made forms because they reflect human needs and are based on human standards.

Natural and man-made forms shape the way how humans perceive their surroundings. For this reason, natural forms can also provide a basis for a perception-oriented methodology and theory of forms.

Human perception of forms is determined by areal contours and the shape of body surfaces. One method of systemising the large number of forms is to take the direction/orientation of the contour or surface as a distinctive feature and characteristic of order.

The principle of distinction can be illustrated by the example of a circle.

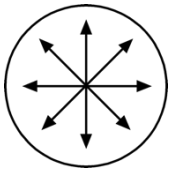


Figure 14: Form lacking direction [3]

The circle is perceived as a circle because its contour lacks a sense of direction. For purposes of typification, its form can be described as "lacking direction". Following this principle, other basic forms can be derived from nature.

Around the year 1970, Zitzmann developed a basic training course for designers at the Hochschule für Industrielle Formgestaltung, Halle-Burg Giebichenstein (Halle School of Art and Design). The systemisation of forms described in this paper is based on Zitzmann's work [2].

3.3.1. Methodology of forms – character of forms

In the following section, four characters of form are derived from forms in nature.

The aim is to present a design-oriented methodology for differentiating forms according to criteria of perception. This methodology helps analyse forms in terms of their visual effect on a user and to apply them purposefully to design tasks. Furthermore, this methodology offers a potential for overcoming the "lack of terminology" so frequently observed when forms are to be analysed and discussed.

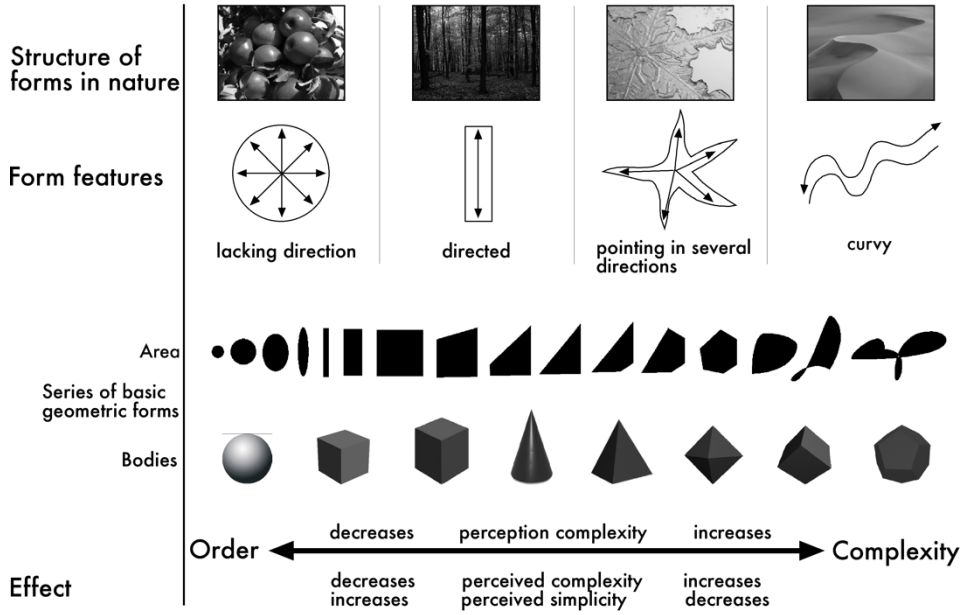


Figure 15: Systematics of forms [3]

3.3.2. Systematics of forms

As a result of analysing forms occurring in nature and reducing them to simple basic geometric shapes, it is possible to develop a system based on different perception efforts.

Let us assume that a circle is perceived quicker, more competently and accurately than a polygon or a complicated curvy/meandering form. However, not only the effort we have to make to perceive a particular shape or form is a differentiating or systemizing feature, but also the different effect the form has on an observer. A circle is perceived as a calmed form free of tensions while a triangle is perceived as aggressive and often as moving.

Based on these principles, a series of forms differentiated by perception effort and feelings triggered can be developed that is of great importance to practical design work. It is highly probable that a planned and desired feeling can be evoked in a person when adequate forms are used.

3.3.3 Form development – quality

A designer can derive fundamental know-how for designing certain effects from this system of forms.

The following three aesthetic qualities present another step towards creating forms in line with human sense and intellectual perception:

- purity of form,
- consistency of form and
- transitional forms and details.

If design processes aim at creating perception-oriented designs, these properties may also be connected with particular objectives. These can be high purity, consistency and compactness.

3.3.3.1. Purity of form

The relationships described in Section 3.3.1 and the series of forms presented in Figure 15 are now transferred to body shapes.

The perception effort and the effects caused in an observer are different for a sphere – for instance – a tetrahedron.

A high degree of purity, understood as a quality feature, is characterised by a lower number of type and form elements. Simple geometric lateral surfaces and a low number of faces and edges are design features to be achieved.

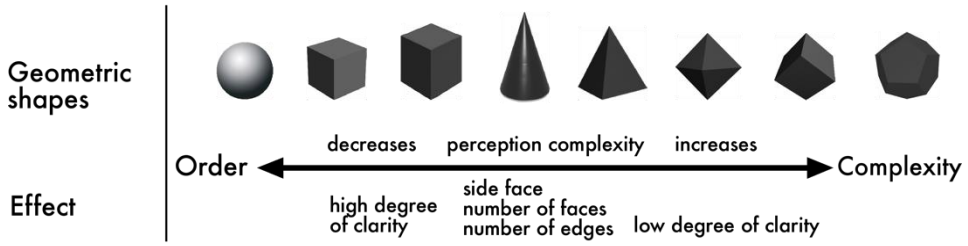


Figure 16: Differentiation between various geometric shapes according to the criterion of purity [3]

3.3.3.2. Consistency of form

The consistency of a form is often linked with the impression of harmony. In contrast, inconsistency conveys disharmony.

Therefore, the following holds: If the design objective is to create a "harmonious" form, the design has to have certain features:

- consistent contour or surface
- consistent direction/orientation and
- consistent curvature.

Consistency of contour and direction/orientation means that the form must not have any recess and sharp bend. Any inconsistency will spoil the harmonious impression and may dominate the design. In other words, the eye "gets stuck" at this point. However, it should also be mentioned that recesses or sharp bends may be created intentionally, for example, as a superior feature (to draw attention).

The third feature of consistency effecting perception is the curvature of a contour or surface. The more complex the curvature, the greater the perceived "disorder", the more disharmonious a form may be experienced.

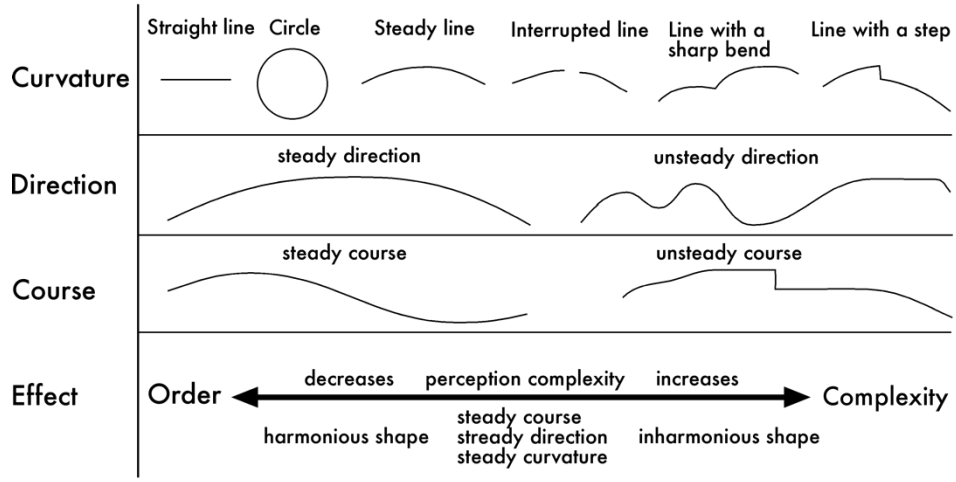


Figure 17: Differentiation according to the criteria of form development quality [3]

3.4. Design methods to create perception-oriented design solutions

The relationship between order and complexity determines the degree and distinctiveness of the shape or overall design. There are no established standards defining this relationship. Too many factors have an impact on the design process. Societal and cultural values, the zeitgeist, individual views and ideas, marketing aspects and design qualifications impact this design challenge.

And yet, it is possible to derive trends and recommendations for designing products. In the course of industrialisation and its concomitant cultural movements and changes, a clear tendency towards creating deliberately ordered forms can be observed. In 20th and 21st century design, attributes such as simple, organised, easy to understand, authentic and honest have been accepted as characteristics of quality.

Of course, the implementation of these characteristics requires complex professional design work. A designer can exert influence on the overall perception-oriented design (shape) during form- and shape-finding processes. Two methods are particularly well-suited to be applied to the engineering design process.

3.4.1. Combining forms to create a compact design and calming shapes

Combining forms to create a compact design and calming shapes are methods suitable to satisfy the need for visual order.

The term *combining forms to create a compact design* describes the combination of various individual forms to achieve a less complex general shape. If the criteria of perception-oriented design are taken as a yardstick, a high complexity of forms may create the impression of being chaotic, unbalanced, overloaded and overtaxing. The functional design shown in Figure 18 is an example of a design solution that is inappropriate from a perception perspective. Such a design may result when a designer works solely to meet

technical and functional requirements but does not take aesthetical aspects into consideration.

In other words, designing with the aim to simplify and harmonise forms is a step in the right direction, i.e., towards a meaningful and sensorially appropriate form.

In principle, there are two possible approaches:

- Developing a form from identical or related forms which are individually visible and appear in an open design (shape). This creates the impression of openness.
- Masking the diversity of forms by "enclosing" them (enclosure, housing). The diversity of forms is covered up and the enclosure fulfils the aesthetical function of the design. This creates the impression of coherence.

In practical designing processes, both methods are typically applied and are seen as methods suitable for calming forms/shapes.

Figure 18 shows the designing process from a functional form to a final perception-oriented shape.

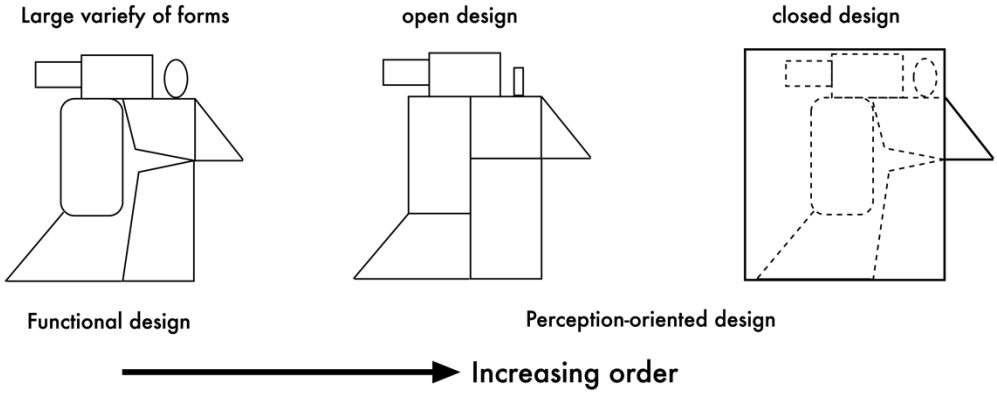


Figure 18: Two methods suitable for calming forms/shapes [3]

Calming a form is a designing method suitable to make a creative decision between order and complexity of the form to be perceived. The degree of order to be created decides about the intended effects.

A clear and orderly form and shape is considered an important and decisive design standard and quality criterion. A high degree of order creates feelings and effects such as

- clarity
- transparency
- security
- perfection
- tastefulness
- high quality, high value and
- long product life.

Evaluations made by both the individual and society always take place in a specific socio-cultural environment. Evaluation standards and concepts of value are always dependent on a particular epoch and culture. Values such as a high degree of order equalling high quality equalling high value equalling sustainability (long-lasting) are, for

example, conceptions of design that were accepted as standards at the end of the 19th century and have been valid to this day.

In product design, the method of combining forms to create a compact design and the method of calming forms take precedence provided the type of product and its intended use allow it. As a result, open, easy to understand and accessible overall designs can be created. While taking into consideration all functional and, in particular, safety requirements, designers should strive to disclose the principles of construction and use. By deliberately simplifying and calming forms, the diversity of construction features can be reduced to create a feeling of order. Using simple basic geometric forms is an important designing approach.

Technical and in particular safety-related reasons often require diverse form elements to be enclosed because such an enclosure also provides protection against external and internal threats. In this respect, an enclosure often also has a sheltering effect. The visual effect is based on the principle of concentration. The diversity created by many individual forms is no longer visible – only the overall design (shape).

This has a calming effect, but at the same time it is also somewhat confusing or even mysterious. At any rate, an enclosure has an ordering effect because the form of the enclosure can significantly reduce form diversity. Both methods are applied to product design. They are suitable for ordering shape features and for reducing or calming designs in terms of their visual complexity. These methods also help finding a product identity in the designing process.

Both methods are exemplified in Figure 19. As a rule, a bike is characterised by an open design. The form elements determining function and use create an open appearance based on the principle of construction and use (arrangement/assembly). The machine tool is accommodated in a housing. The design of the housing has an aesthetic function.

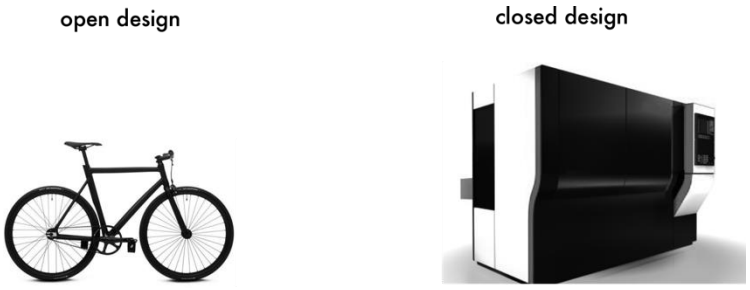


Figure 19: Open and closed design as exemplified in a bike and a machine tool [3]

4. Summary

Form and shape present the major functional and perception prerequisites for implementing technical and aesthetic product requirements in the process of product development. While the engineer follows the principle of form follows function, the industrial designer creates perception conditions that manifest themselves first and foremost in use processes. Both engineers and designers alike plan, visualise and create the geometric-material entirety of a product against the background of the specific objectives of their discipline.

Developing meaningful perception-oriented designs is a primary concern in product design. The approach to developing creative design solutions is based on the relationship between perception and behaviour. A user's or a user group's perception, emotions and behaviour can be purposefully influenced by product design.

A perception-oriented theory of form and shape introduces fundamental principles and interrelations, but it also illustrates the directions and ways to be taken in the design process. To this end, order and complexity are two possible design approaches suitable to develop the overall design (shape) in line with the effects desired. However, this does not mean that the entire range of potential design options available in a designing process will be exhausted. The professional industrial designer will make use of his or her expertise in composition and his or her skills acquired in practical design work. A high degree of sensitivity to form, colour, material and surface aesthetics are individual prerequisites for professional work.

Product development is an interdisciplinary process. Such an interdisciplinary and integrative approach is required if all qualities, expected today of a quality product, are to be achieved. New production development methods, shared drafting, design and construction tools as well as new forms of organisation enhance integrative working processes.

New design concepts such as the Masters Course in Integrated Design Engineering offered at the Otto von Guericke University Magdeburg have successfully taken up this challenge.

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