

# Stuff

The Nature of Chemical Substances

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## STUFF: A PHENOMENOLOGICAL DEFINITION

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Jens Soentgen  
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Photo by K. Ruthenberg (2006)

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### Phenomenological Investigations on the Concept of “Stuff”

There is a use of the term “stuff” in which objects such as wood, cotton, aluminium, salt or sugar are considered different kinds of stuff. These objects are otherwise also named substances, yet the word “substance” refers more to a scientific terminology. In the following, I want to explore a phenomenological definition of “stuff.”

Chemists are experts in the art of describing and defining stuffs (substances); some are even able to write the most complicated structural formulas at an astounding speed. However, if one doesn’t ask about this or that stuff but about stuff as such, then the experts begin to falter. Which characteristics do all stuffs have in common? How can the category of “stuff” be defined? If such questions are raised, the answers are usually unsatisfactory. On the one hand they are often far too concrete: Answers will include that stuffs have a specific density, a specific melting point and in addition they all have a chemical formula. On the other hand, the answers are often far too abstract. One example is the definition under the entry *Stoff* (stuff) in the Römpp chemical dictionary. We find here the following definition of stuff:<sup>1</sup> “An expression used in chemistry to designate every kind of matter, i.e. the types of appearance, which are marked by invariable typical characteristics, regardless of their external shape” (Column 4322). This answer is so abstract that it is incomprehensible. The main clause states categorically that *Stoff* (stuff) = Designation of every type of matter. However the subordinate clause follows with the limitation that evidently not “every type” of matter is meant, but only those appearance types which have invariable typical characteristics, regardless of their external shape. So what does this definition really mean? Is the term “stuff” equivalent to the term “matter” or not? The definition as a whole isn’t very informative. It states that certain objects in the world are marked by invariable, typical characteristics. This isn’t only valid for stuffs, but also for all identifiable objects. It is astonishing to find such a careless definition in a chemical dictionary of all places, considering that this concept is the very basis of the discipline.

The answer to the question “What is the meaning of ‘stuff?’” isn’t meant to give us a criterion for distinguishing between stuffs and non-stuffs. It serves to contribute to a deeper understanding of the practice of distinguishing which we generally use without issue in our everyday life. In everyday life we have no difficulty in distinguishing between stuffs such as sugar and a thing such as a sugar bowl. Transformation of a thing—an apple—into a stuff—applesauce—is a simple procedure. We know, that there are important differences distinguishing our manners of dealing with objects

<sup>1</sup> Römpps *Chemielexikon*, 9th ed. Stuttgart: Thieme, 1989.

(things) and of dealing with stuffs. Stuffs can be cut into portions without losing their identity. A thing would be destroyed if we treated it similarly. Stuffs can be mixed with other stuffs but we cannot mix one thing with another thing. Stuffs move differently than do things: they flow, drop, evaporate, or trickle, while objects roll, go, or skitter. Both stuffs and objects (things) can undergo certain transformations without losing their identity, but these transformations are of a different nature. Thus a broken thing (for example a bicycle) can be repaired or botched but it is still the same thing. Parts of the object can be replaced by other parts but the thing itself is still the same. However it would be nonsensical to speak of repairing stuffs. If a thing is shredded, it no longer exists. The stuff from which it is made, however, still exists—this is the cause of most of our environmental problems. Stuffs can exist within other stuffs in a way in which one thing cannot be found within another thing: For example, wheat might be an ingredient of ketchup,<sup>2</sup> which would be important for people allergic to wheat to know. It might be found even in the smallest quantity of ketchup. However any thing which is part of another thing would not be distributed in this manner. We are intuitively aware of all these differences in everyday life. However, how can they be described? In the vast field of current literature about common-sense ontology<sup>3</sup> we find many contributions describing things, processes, events, colours, and even geographical objects. Stuffs seem to be rather neglected in this discussion, which is strange, as stuffs play an important role in both our common-sense experience and in our common-sense ontology.

Does an investigation on the notion of stuff bear any relevance for chemical research? It is indeed irrelevant when deciding between competing theories. It neither leads to any new synthesis methods nor can it be the basis of any new structural explanation. However it is of great importance for the *understanding* of chemistry.

In my German publications on this subject I speak of *Stoff*.<sup>4</sup> I am using the English word “stuff” here although this word obviously doesn’t have quite the same meaning. The word is rather ugly and furthermore it isn’t as specific as the German pendant (Buchlere 2004, 73-97). Nevertheless both words have the same root; they are related to the Old French term *estoffe* (Modern French, *éttoffe*), which means material to stuff some object, to fill something with. There are several theories on the ultimate etymology. It has been argued that the word is related to the Greek *στυφειν*, which means to tighten something, to fasten something (Baist 1883, 112). The expression was brought to the West by the Byzantine silk-weavers after the seventh century. The etymology deriving from the Old High German word *stopfōn* seems to be less plausible.<sup>5</sup>

The German term *Stoff* is used frequently both in scientific and everyday language, while the English term seems to be more restricted to everyday use. However it is used

<sup>2</sup> According to Pollan (2006, part I), corn is nearly omnipresent in the US-American food chain.

<sup>3</sup> See Bunt (1985, 37-70) and Hayes (1985a, 1-36; 1985b, 71-107). Whether the interest for naive physics leads to real technological progresses in Artificial Intelligence, is meanwhile doubted in the AI-Scene. See also Smith and Casati (1994, 225-244).

<sup>4</sup> See Soentgen (1997b; 1997c, 241-9). I recognized the importance of the fractal forms of stuffs already in my first publication on the subject; see Soentgen (1997a, section 17).

<sup>5</sup> See Lemma “stuff” in *The Oxford English Dictionary*, 2nd ed., vol. 16, 982-987. Cf. Rey (1998, 1328); Gamillscheg (1969, 401).

in texts on the philosophy of chemistry<sup>6</sup> and is also found in translations of German phenomenological investigations on *Stoff*. “Material” seems to be a rather inadequate translation. According to the *Encyclopedia of Materials Science and Engineering*, material is defined as “physical matter that is manipulated and used by man, generally without a major chemical conversion” (vol. 1, Introduction, XV). The word “material” refers to a functionalised stuff. The term “stuff” seems to be more restricted to chemical products, and as the focus of this investigation isn’t on the chemical ontology but rather on our everyday ontology, this word also seems to be less appropriate.

Stuffs are not only objects of scientific research, they are in fact part of our everyday life. Everyday we deal with stuffs. We drink water, eat yoghurt, inhale cigarette smoke, use cotton wool or hair gel for cosmetic purposes, use glue, toner and rubber in the office. Although we are very often directly interested in the stuff as such, there are occasions when we perceive a portion of stuff as an individual object (a thing). A spoonful of marmalade can be seen as a sculpture. We can treat snow as a stuff, form snowballs or a snowman, but we can also switch to another mode of perception and look at the single portion of snow as an individual object.

It depends on the context and on the situation whether we prefer to take objects as samples of a stuff or as individual things. In some contexts we tend to deal more with stuffs as such; especially in the contexts of eating and drinking or bodily care and to some degree also in the context of clothing. In other contexts we are more likely to look for individual things, as for example, in social life. Sometimes it depends on a certain question, if we look for stuffs or for individual things. In interpreting the painting *The Man with the Golden Helmet* it is necessary to consider it as a unique work of art—in the context of other works of art. In answering the question whether it is a true Rembrandt or not, it is common practice to study it as a complex sample of painting materials. Our visual perception allows both approaches; we can see things as easily as stuffs. If we want to see the thing (the work of art in the example), we generally regard it from a distance of roughly one meter. If we want to see the stuff, we usually reduce this distance: We look at the object more closely, try to see it with sidelight, not in central incident light, in order to observe the small fractal forms that are typical for any given stuff. However this isn’t our normal everyday mode of visual perception, although it is typical for people working in certain professions, such as carpenters or restorers. Our everyday visual perception is generally thing-oriented.

Looking at another mode of perception, oral perception, we notice an interesting difference: It is quite rare that we perceive something in our mouth as an individual object. Even if we do so, as is the case when swallowing a fishbone, our perception is vague and essentially imprecise. We have to take the object out of our mouth and look at it to see the object and identify its form. In the mouth we only have the impression that there is a disturbing object. The oral sense does little to help us study and identify objects, but it is of greater value in identifying stuffs.<sup>7</sup>

<sup>6</sup> See van Brakel (2000), especially chapter 3.1.

<sup>7</sup> In the early days of chemistry, the oral sense was an important medium of chemical investigation; for example, for the creation of the important chemical classes of acids and bases it was crucial. Also physicians used their oral sense much more than nowadays. For example Paracelsus (1493-1541)

The French perceptual psychologist Jean Nogué, who was deeply influenced by the early phenomenologists, noted that the oral sense is a “sense of stuffs” (1936, 232). The German phenomenologist, Hermann Schmitz, writes more precisely: “The normal perception in the mouth happens during eating and drinking, and this is generally ... a perception of stuffs, which can hardly be reinterpreted into the perception of things” (1978, 229).

Eating and drinking are not only very appropriate for the perception of stuffs, they are also ontogenetically our first occasion of identifying and distinguishing stuffs. Even newborn babies can successfully differentiate between kinds of stuff by accepting milk and refusing tea. This is an interesting fact to be considered, as many philosophers hold that our first encounter with the category “stuff” is through manual work. For example, Wilhelm Schapp, Husserl’s second Ph.D. student, wrote: “There is a primary way, in which stuffs appear. ... It is the working on things, the operation of the craftsman, of the worker on things and their stuff, the sawing, drilling, hammering, filing, chipping, hauling, pulling, pushing and every thing alike. ... In these activities stuff primarily appears” (1953, 19f). I think this reasoning does not reveal the real introductory context of the category of stuff. The first context is, surely, eating and drinking. To get a vivid impression of a special stuff, and to illustrate the following general remarks, I humbly suggest that the reader enjoy a piece of chocolate. In eating chocolate, we experience a stuff, so to speak, instantaneously, not bound within a thing.<sup>8</sup>

#### *Stuffs and things*

These observations are important because they contradict the opinion that the identification of a certain stuff or another depends on the identification of things. Currently this opinion is widely spread, being held, for example, by Johann Weninger.<sup>9</sup> He writes as follows:

only things are concrete, not stuffs. We can only gain a concept of stuffs if we ignore the quantitative features (mass, volume...), conditional features (temperature...) and form distinguishing features and only take into account the remaining measurements which can be counted as stuff properties. The bearer of these remaining properties, which we call stuff, is necessarily an abstract object. (Dierks and Weninger, 1988, 75)

In a similar but more sophisticated way, Peter Janich and Nikos Psarros also think, that “Stuff” and “Stuff-names” are secondary categories called “abstractors.”<sup>10</sup> The point

advised the physician to test the taste of the urine of his patient, whether it smells pungent or sweet, and Thomas Willis (1621-1675), one of the most famous men in seventeenth century medicine, who also treated members of the royal family, remembers in his *Dissertatio de urinis* (1670) the “wonderful sweet taste of some urines, as if they were saturated with honey and sugar.” See von Lippmann (1929, 687).

<sup>8</sup> The German phenomenologist Hermann Schmitz holds that these ways of perceptions may be seen as forms of Husserl’s “*Wesensschau*” (1996, 164-172).

<sup>9</sup> A longstanding member of the *Ausschuß für chemische Terminologie am Deutschen Institute für Normung* = the German standards institute committee for chemical terminology.

<sup>10</sup> Psarros (2001a, 23-29), available online at <http://www.hyle.org/journal/issues/7/psarros.htm>, accessed 21 October 2007; see also his critical review of my definition: Psarros (2001b, 43).

being made here is clear: stuffs don’t belong to the concrete inventory of our environment. On the contrary they are the result of intellectually abstracting, reflecting and combining. In this we identify stuffs by comparing objects and then making note of similar material qualities. This position, called “reism,” was influentially defended by Franz Brentano in the nineteenth century. The German chemist, Wilhelm Ostwald, applied it to chemistry in order to formulate the opinion that stuffs are abstract entities (1912, 1).

“Only things are concrete, not stuffs.” This means that if we want to identify a stuff, we first have to identify a thing. Is this really the case? Even in visual perception there are situations when we encounter stuffs which are not bound into things, as for example when we are in a snowstorm or when we swim in water. In oral perception, as I have shown, we generally encounter stuffs as such, and only very rarely stuffs bound within things. Thus the inference that we need things to identify stuffs isn’t valid. One general argument against this position is that if we were to construct concepts of stuffs starting with abstraction and comparison of similar features, this would lead to a *regressus ad infinitum*. How can I decide which objects resemble each other with respect to their stuff (i.e. “water-objects”) if I don’t know in advance the stuff “water”?<sup>11</sup> To sum up: Contrary to the abstraction theory, I hold that stuffs are as immediately identifiable as things, and it isn’t the case that a certain stuff or another can only be identified if we first identify a thing.

#### *Why phenomenology?*

To define the concept of “stuff” we have to ask ourselves: Which elementary properties do I know that all stuffs possess (including those stuffs not found in chemical laboratories)?<sup>12</sup> Thus we are dealing here with the collection of descriptive criteria distinguishing one everyday stuff from other stuffs. Traditionally this research area has been known as phenomenology. All scientific studies claiming to be phenomenological have been based directly or indirectly on the work of the German philosopher, Edmund Husserl. The spectrum of phenomenologists would subscribe to Husserl’s admonition “To the objects themselves” (*Zu den Sachen selbst!*), which means taking a fresh approach to concretely experienced phenomena; an approach as free as possible from conceptual presuppositions and the attempt to describe them as precisely as possible. Moreover, most phenomenologists hold that it is possible to obtain answers to the question of the essential structures of the phenomena on the basis of a careful study of experienced examples and imaginary systematic variation of the examples.

In contrast to positivism, phenomenology doesn’t restrict its basis to the range of sensual experiences but has a broader and maybe vaguer concept of experience. For example, many phenomenologists admit as real on equal terms non-sensory data such as relations or ideas. Consequently, many phenomenologists don’t reject universals. Moreover, early phenomenology did provide fresh impulses to the study of universals. In contrast to an analytic philosophy that attempts to reduce the given to certain ele-

<sup>11</sup> For a similar argument, see Schelling (1985, 580); edition of 1858: vol. 1/3, 512.

<sup>12</sup> A chemical stuff is a stuff which is produced by chemists or the chemical industry or which can be traced back to the chemical industry.

ments, phenomenology is sceptical about reductionary interpretations of the given. In this sense, it is a philosophy from “below.” Therefore, the following cannot provide any real surprises or anything “new”—if not the surprise to have a close look at the self-evident. It merely sums up how stuffs appear in our everyday world. Although we usually only have one or two characteristics in mind, when thinking of stuffs as such, I will try to display the entire set of properties. This study proceeds phenomenologically by systematically including everyday experience. In addition it incorporates a great deal of literature from the field of phenomenology.

Husserl himself was, in his philosophical writings, not very interested in the study of stuffs. Even in his discussion of the difference of *res extensa* and material object (or object and phantom) in the second book of his *Ideas*, he does not discuss stuffs as such. Stuff only occurs in form of a *chiffre* as substantial properties (Husserl, 1952).<sup>13</sup> This is baffling, as in Husserl’s everyday life, a certain stuff, tobacco, played an eminent role. Husserl was a heavy cigar-smoker; in 1928 and 1937 he suffered nicotine-intoxications and had to stay in hospital for several weeks. He tried to get rid of his addiction, but in 1937 he wrote to Ludwig Landgrebe from the hospital: “Some weeks I tried to detox radically... My health meliorated, but I was not able to think scientifically, and thus I was not able to continue” (Vongehr 2002, 14). It seems as if tobacco played a major role in the development of the phenomenological theory. Although the category “stuff” was not acknowledged in Husserl’s philosophical work, Husserl’s idea of the study of our everyday-ontology led to the study of stuffs. His famous critical discussion of nominalism and his most influential arguments for the real existence of kinds in his *Logical Investigations* were also helpful (Husserl, 1984, part 1, chapter 2).

Martin Heidegger didn’t work on stuffs as such either, although he had a deep interest in the study of objects (things). Nevertheless, in *Being and Time* he made important remarks on the appearance of stuffs in working-processes (1927, 70). In the French phenomenological movement, we find several brilliant and influential descriptions of single kinds of stuff (i.e. honey, water, etc.), but no formal descriptions of the category “stuff.”<sup>14</sup>

We find some extensive investigations on stuffs in the work of some of Husserl’s early students, which have often been unjustifiably overlooked. Indeed some of Husserl’s first students, such as Wilhelm Schapp (1884-1965)<sup>15</sup> or Hedwig Conrad-Martius (1888-1966)<sup>16</sup> worked on the subject. The most important and most complex investigation on the concept of stuff was carried out by Hans Lipps (1889-1941), who

<sup>13</sup> See the lucid explication of Husserl’s position in Rang (1990, 331-337). See also the similar discussion with similar examples (but without referring to Husserl) in Strawson (1959, §6, 38-40).

<sup>14</sup> For example, Sartre (1943, 1033-1052); see my interpretation in Soentgen (1997a, 170-176). See also the phenomenological descriptions of water and other stuffs in Ponge (1961). In the work of Merleau-Ponty I only found occasional remarks on stuffs. As with most phenomenologists, Merleau-Ponty was more interested in the study of the perception of objects (things) than of stuffs (Merleau-Ponty 1966).

<sup>15</sup> As these authors are less known or maybe even unknown in the English and American discussion, I add, where available, some information on them.

<sup>16</sup> Conrad-Martius discusses materiality in general (1923, 159-333), but also certain stuffs as water, gases, metals and glass. For stuffs, see especially 256-290.

was both a physician and a philosopher (Lipps 1928). The subject was treated later in more detail by Albert Grote (1898-1983) and is still being discussed in the works of continental phenomenologists, especially those of Hermann Schmitz (born 1928).

I have learned a great deal from the discourse in the phenomenological tradition on the concept of stuff. Stuffs are also an issue in analytical philosophy. Here, we find two nuclei of the discussion: Firstly, the discussion on mass terms, which has been initiated by Helen Cartwright’s famous essays;<sup>17</sup> and secondly, Putnam’s and Kripke’s work on natural kinds.<sup>18</sup> Both strands are brought together in Peter Hacker’s admirable essay on “Substance: Things and Stuffs” (2004),<sup>19</sup> which includes a description of stuffs from an analytical point of view. It is worthwhile noting that Hacker’s conclusions and mine converge closely.

My study is based on the following methodological principles:

- Wherever possible the definition excludes the use of vocabulary taken from specialist disciplines and isn’t constructed on the basis of any specialist discipline argumentation. Instead our everyday expectations concerning stuffs are explained. This is to avoid the risk of adopting preliminary theoretical decisions through the use of specialist concepts, which would, first of all, have to be justified.
- The definition is formulated as a descriptive definition (*definitio descriptiva*). The procedure consists of compiling a list of as many characteristics of the object being defined until a clear definition is reached. This procedure has the advantage that the sense of the word being defined can be stabilised using multiple supports.

The criterion, whether the definition has been completed, consists of a simple test: Take an object which is generally considered to be a stuff, and you will find that all characteristics which I have listed apply to it. On the other hand, objects which are generally not called stuffs should not fit within the established list of characteristics.

A phenomenological methodology, which relies on phenomena—understood as everyday experiences—is often criticised as being naive, old-fashioned and arbitrary. Analytical approaches to ontology often, at first, take a close look at grammar, and thus seem to be much more professional, especially when decorated with logical formulas. However, I want to point out that a mere grammatical approach to ontology is also problematic. Without hidden references to phenomenological evidence, it easily leads to paradoxical ontological results. If we only relied on grammatical analysis, we would have no definite evidence that the grammatical distinction between countable and uncountable nouns refers to an ontological distinction, because Asian languages such as Japanese, Korean or Chinese don’t make such a distinction at all (Harweg 1999a). These languages treat every noun as if it designated a stuff. Thus, nouns in the Chinese, Korean or Japanese languages behave like English mass nouns such as milk, water or flour.

This example shows that grammar can often be helpful in ontological analysis, but

<sup>17</sup> Shieva Kleinschmidt collected a bibliography concerning this discussion which is available on the net: <http://www.eden.rutgers.edu/~shievak/StuffBibliography.doc>, accessed 21 October 2007. Although the collection omits many important contributions, I found it useful to some extent.

<sup>18</sup> See the chapters concerning this discussion in van Brakel (2000, chapters 2.5, 2.6 and 4).

<sup>19</sup> See also Hacker (1979).

it cannot always be taken literally and is by no means a “mirror of nature.” Therefore, even though I will by no means neglect the value of linguistic analysis,<sup>20</sup> it seems to me that the phenomenological approach to ontology remains an important possibility in philosophical research.

What about the results of this approach? Although I hope that I have achieved a certain amount of progress in the above discussion on stuffs, it is clear that the demands on the discriminatory power of the definition should not be too high. Even chemical definitions for classes of stuffs are relatively imprecise and always raise doubts, especially when physicists take part in the discussion. What is the exact definition of an acid or a base, of a metal or a nonmetal, of a Heusler-compound or a Perovskite? As even chemical definitions of kinds of stuff are rather vague, a philosophical definition of a formal concept that is much more general should be allowed to be somewhat imprecise.

### How Shall We Define “Stuff”?

The concept of stuff which I am suggesting can be summarised in six sentences.<sup>21</sup>

1. Stuffs can be divided into portions.
2. Stuffs display characteristic structures (*Stoffe sind Gebilde*).
3. Stuffs are material.
4. Stuffs have tendencies (*Stoffe haben Neigungen*).
5. Stuffs occur at the same time in different places.
6. Some stuffs are natural kinds.

I am now going to explain these sentences consecutively. Then I will try to discuss whether these sentences, which stabilise the concept of stuff, form a systematic semantic structure.

#### *Stuffs can be divided into portions*

One of the best-known characteristics of stuffs is that they can be divided into portions. So far, so good. But what does this really mean? What is a portion? Obviously it is a part of something. However there are many types of “parts of something.” In addition to portions there are members, fractions, pieces, ruins, remnants, etc. What is so special about portions? Let’s take a piece of some kind of chalk as an example. Even the smallest piece of this chalk is chalk. What is unusual here is that stuffs can be further divided up to a certain extent without losing their identity. This means I can divide a piece of chalk arbitrarily, but I always end up with more pieces of chalk. Linguists

<sup>20</sup> Albert Grote (1972) combined in his ontological investigations grammatical and linguistic analysis in a very fruitful way with phenomenological observations. Yet Grote did not analyse only one grammar, as is the custom in analytical philosophy, but systematically took into account also the grammar of non-European languages.

<sup>21</sup> For a more detailed discussion, see Soentgen (1997a, 89-120).

would say: mass noun denotations are divisible without requiring a change of name (Harweg 1987, 798). This is different, if we take a look at things. If we divide a chair for example, the parts are not called chairs, but rather leg of the chair, backrest, etc.

There are many colloquial names for stuff portions. They can be put in order according to their decreasing size. Thus, there are true hierarchies of denominations in some cases. For example, for sand there is a barrel, a bucket, a scoop or a spoonful. You might think that this theme could be continued further, that every sand portion, no matter how small it is, could be further divided into even smaller portions. What about this view? Does it hold? Can stuffs be arbitrarily divided into finer portions? For example, can a drop of water be divided again and again into new if somewhat smaller drops? This isn’t the case phenomenologically. There is already a size range above the molecular level, a vague spectrum of micropotions, which divide or can be divided; but by so doing they gradually lose the typical properties of the stuff and take on new ones. There is a borderline beyond which parts cannot be divided: this begins for the stuff sand with the grain, for soil with the mote, for wood with the splinter. If the grains, motes, and splinters are further pulverised, the result is either given a new name or simply called dust.

The belief that the specific properties of a stuff, its qualities, don’t depend on its quantity is a useful idealisation. However this is only true within a certain size spectrum, which differs from stuff to stuff. Closer observation reveals that also in the case of stuffs, division is a neutral process only within a certain range. Very small portions of a given stuff may have different properties than bigger portions. One example is the grain of sand, which doesn’t behave like sand at all. In other cases, the differences between the small and the “normal” portions are less obvious, but still within a phenomenological range. For example, powdered sugar is still sweet and, although it is made of crystal sugar, it has a slightly different taste than crystal sugar.

Summary: The statement “stuffs can be divided into portions” isn’t strictly speaking valid; at best, only to a certain degree.<sup>22</sup> Nevertheless it is the most important—or in any case the best known and most discussed—element of the concept of stuff.<sup>23</sup> However it isn’t the only defining element which distinguishes stuffs from non-stuffs. If it were so, the term “nails” would also refer to a stuff, as nails are treated like a stuff in the ironmongery: They are sold by the kilo (or pound), weighed and filled in boxes just like sugar. There must be more criteria that distinguish stuffs from non-stuffs—at least, if stuff is an ontological category, and not merely a question of perspective.

<sup>22</sup> Hacker says, that stuffs are “relatively dissective” (1979, 242). See also Harweg (1987).

<sup>23</sup> See the very clear explanation of dissectivity in Hacker (1979). For a mereological treatment, see Needham (2003). More titles of the abundant literature can be found in the already cited bibliography of Kleinschmidt.

*Stuffs display characteristic structures*<sup>24</sup>

Stuffs are usually kept in standardised forms on the shelves of the chemistry laboratory. Liquids are filled into standard containers. The filling of solid stuffs is aided by pulverising the stuffs first. This process of pulverisation is also important for working with chemicals so that they can be weighed out exactly in the amounts needed for quantitative experiments. Nevertheless the custom of pulverisation might have helped to support the false idea that stuffs don't have structures. This isn't the case. It is true that stuffs can be divided within a wide spectrum without losing their specific characteristics; it is true that stuffs can take different shapes within a broad range. However it would be wrong to conclude from this that stuffs have no forms and no structure at all.

Only a few stuffs we know show conspicuous structures such as the hexagonal columns of basalt. However small pieces of stuffs always show distinctive textures such as the grain of wood, the shell-like breakage of glass, the porous surface of clay. We can recognise stuffs at first sight due to their individual specific structures.<sup>25</sup> Because we intuitively recognise these individual structures, we can easily distinguish irregular stuff portions, such as pieces of broken glass, bits or crumbs from pieces, which have been intentionally divided. To give a structure to a stuff is rather different from drawing a figure in an empty space. The latter is always successful, but structuring can miscarry if the point is reached when the stuff prefers to form its own structure, the work piece cracks, breaks or tears. Seen from the perspective of the worker, the stuff was brittle. But we could also say that it merely reacted to an external stimulus by following its own dynamic. Therefore by shaping a stuff we are always superimposing the individual structure of the stuff with our chosen structure. The same is true for liquids. These can indeed be kept in containers of almost any shape. However they have their own characteristic distinctive shapes. These are the drops and the specific movement forms such as whirls, etc.<sup>26</sup> Whirls can also be observed in the case of air, dust and gases.

I will sum up these observations by stating that every portion of a stuff displays, or at least can display, structures that are typical for the stuff. Every portion of stuff has, at least potentially, a structured inner organisation. The gestalt psychologist David

<sup>24</sup> Inadequate translation of "*Stoffe sind Gebilde*." The German word *Gebilde* means at the same time "structured form" and "creation." In my opinion, this expression is particularly fortunate, as it not only includes the sense of the creative formative process (*gebildet* = formed) of which every stuff portion is the result, but also the picture (*das Bild* = the picture), that is, the aesthetic attraction. For it is indeed the aesthetic element, which even many chemists find fascinating, too. The term *Gebilde* cannot be translated literally; I tried to find an indirect translation. For the history of the notion see Barth (1965, chapter 10, 611-682); also concerning the expressions *Gebilde* and *Gestalt* respectively (308-328); also Barth's important interpretation of the *Critique of Judgement* in Barth (1959, chapter 6, 420-505). Heinrich Barth (1890-1965) did not describe himself as a phenomenologist. Yet his systematic and historical works treated in a brilliant and enduring way a subject, which was central to phenomenology, viz. the notion of the phenomenon. For the relations between Barth and phenomenology, see Soentgen (2001, 7-23).

<sup>25</sup> For more detailed descriptions, see Soentgen (1997c).

<sup>26</sup> See Quéré (2003). See further the distinctive flow forms of different kinds of water in *Sensibles Wasser*, vol. 2, Ed. Institut für Strömungswissenschaften, Herrischried: 1993.

Katz (1884-1953)<sup>27</sup> investigated the appearance of stuffs and noticed, that it is always possible to distinguish the "*eigenstructure*," which a given stuff (e.g. wood) has in itself, from the artificial form which the carpenter or carver gave to it. It is possible to see these forms: "We discover elements of minimal extension which are difficult to delimit against each other, which owe their visibility to minimal differences of luminosity and tint. They are so small, that it is possible to discover droves of them within one square millimeter" (1925, 36). Involuntarily, we use our fingertips or our lips to perceive these structures. Katz states that the perception of material structures has a much higher biological relevance than the perception of colours.<sup>28</sup> Summarising his investigations, he says: "There are tactile structural elements, which are characteristic for a given stuff, and they are independent from the form, which has been forced upon it" (37). These structures are not only typical for the stuff, they can also bear information on the history of the specific portion.<sup>29</sup> Each divisional process starts from one structured form—and results in a new structured form. The form represents not only the geometrical limits but also the result of the formative process. The German phrase "*Stoffe sind Gebilde*" includes these two aspects.

For a long time the "*eigenstructures*" of stuffs have been overlooked. This is perhaps due to the strong tradition of Neoplatonic philosophy, which taught that stuff was amorphous. On the other hand, neglecting the structural character of stuffs could be due to the fact that the individual stuff forms didn't really fit into the standards of Euclidean geometry. Nowadays, an encouraging interest in the "*eigenstructures*" of stuffs can be observed within the precise sciences themselves as well as in science education.<sup>30</sup> Fractal geometry, with which these structures can be approximated, may be partly responsible for this development.

The atomic and molecular structures, which play such an important role in chemistry, are distinct from the concrete, visible structures which I am referring to here. These are structures of atoms and molecules on a much smaller scale than the phenomenological microstructures. Although the cognitive and heuristic value of these models remains unquestioned, the following remarks from a study by Markus Huppenbauer and Armin Reller show once again the limitations of the chemical formula which have often been observed:

The ideal structure shows a suitable construction plan for scientific and technical disposition. For example, the coal model is fairly adequate as a description of the average composition of coal. However the model gives no concrete geographical

<sup>27</sup> Katz became famous through his "Die Erscheinungsweise der Farben und ihre Beeinflussung durch die individuelle Erfahrung" (*Zeitschrift für Psychologie*, Ergänzungsband 7, Leipzig 1911), the 2nd edition of which was published in an abridged translation as *The World of Colour* (London 1935). As Katz himself points out (see 30 of the German edition), this work was influenced by Husserl's lectures in Göttingen.

<sup>28</sup> See Katz (1925, 36). Gibson and his school of "ecological optics" later described similar observations (1979, 25-29).

<sup>29</sup> See Huppenbauer and Reller (1996, 103-115).

<sup>30</sup> Minssen has been particularly concerned with the aesthetic reality that we meet in the form of portions of stuffs (1986).



and chronological information at all concerning the ecological environment of those plants from which the particular piece of coal originates. That is to say that the individual history of the piece of coal has been faded out. The structural model of coal ... only gives us information about the average, continually reproducible exploitation possibilities of this source of energy. This model suppresses the ecological-historical dimensions of the individual pieces of coal. (Huppenbauer and Reller, 1996, 109)

There is no denying the value of structural formulas as they do contain a great deal of information about a stuff. What Reller and Huppenbauer point out is that this structural formula gives us only an average and very much simplified picture of a concrete portion of a stuff. A stuff isn't identical with its structural formula. Even though atomic physics has contributed a great deal to our understanding of the properties of stuffs, these properties cannot be completely derived from the properties of atoms and molecules. It isn't even possible to infer the existence of stuffs from the existence of kinds of atoms and molecules.

#### *Stuffs are material*

In our everyday world, we can easily distinguish material and immaterial objects. Light rays, shadows, rainbows, sounds, emotions or thoughts are immaterial; cars, chairs, umbrellas are material—and of course, all “true” stuffs are material. Although it isn't difficult to draw a distinction practically, it seems to be tricky to tell how, according to which criteria, we distinguish material objects from immaterial ones. The scientific, but not appropriate for a phenomenological investigation, way would be to rely on a measurement: Material objects have a certain mass, immaterial objects don't. This is a precise criterion, but not an explanation. So let us ask once more: How do material and immaterial objects differ? Let us think of a situation during a summer thunderstorm when the sun breaks through the clouds and the veil of rain. The rays cross the whirling masses smoothly and are straight as an arrow. At the same time we see two contrasting orders: the order of the material structural forms, which differ from the storm and the light rays that belong to the order of immaterial forms.<sup>31</sup> I have this storm picture in my mind's eye as I try to give a contour to the material/immaterial distinction. I suggest the following definition of this distinction:

- The sensual complexity of material objects is higher (Strawson 1993, 40), they can appear in different modi, and offer experiences to more than only one sense. A drop of olive oil can be smelt, tasted, felt and heard. Material objects can surprise us again and again, showing completely unforeseen sensual properties. They are, as the phenomenologist Hermann Schmitz explains in developing a thought-motive of early phenomenology, more opaque and sensually more profound than immaterial objects. Immaterial objects, on the other hand, are less complex. A sunray can only be seen, it cannot be heard or smelt (at least it is seen as an anomaly called synaesthesia if a person says that he can see sounds and hear colours.)
- Material objects are more permanent than immaterial objects. A voice disappears, a stone remains. The sounds of a fight disappear (despite Rabelais' imagination of

the frozen words, which defrost in *Gargantua* and *Pantagruel*), but weapons and other material objects can be found at the battlefield centuries later. Even if we don't see a material object at the moment, because it is, for example, in a cupboard, we can rely on the fact that there is the constant possibility of getting it to reappear again.<sup>32</sup> That's why we can store material objects while, in the case of an immaterial object, as for example light, we can only create them again and again.

- If we give a material object to another person, we lose it, while this isn't necessarily the case with immaterial objects. We can share emotions or knowledge; they don't lessen. However the possession and transfer of material objects is in a certain sense exclusive (Hacker 1979, 241f). Only one person can eat a muffin, but many people can hear a speech.
- Immaterial objects don't have an age, while we expect that every material object has an age even if it might not be possible to determine it.
- Material objects have a higher causal relevance and limit our action possibilities much more considerably than immaterial objects do.<sup>33</sup> Therefore, their vital weight is higher. Material objects stand in each other's way, they block light and throw shadows. A colour may look poisonous, but only a stuff can be a true poison. Our primary vital needs can only be satisfied by material objects. That is why we pay attention much more to material than to immaterial objects.

Every stuff is a material object in the above sense. It is sensually complex; that means it contains an abundance of stimuli for all our senses. It is relatively permanent; which is why we can keep stuffs and work with them. The transference of a certain amount of the stuff to another person entails that we no longer possess this amount. Every portion of stuff has an age: it came into being at a certain date. A stuff is causally relevant: stuffs make us healthy or sick, poison or heal us. If these features are omitted, then the result will be that e.g. warmth or information is also a stuff.<sup>34</sup> Such a result would appear strange to both spontaneous and scientifically trained thinkers.

#### *Stuffs have tendencies*

Everyone knows that stuffs offer possibilities of how to deal with them. You can drink water, scoop it with a spoon, fill it into containers and it will take on the shape of those containers. This kind of characteristic is mostly marked by words, which are usually formed according to the following pattern: verb root plus a suffix, such as -able/ible or -be. Examples: drinkable, combustible.

Analytical philosophy speaks of dispositional predicates, which are represented as so-called universal implications: “salt is soluble” means “every salt sample will dissolve in water.” This explanation is indeed correct and clear but it is too formal. There are at

<sup>32</sup> The idea of defining the term “material” or the concept of materials using the concept of constant possibility is derived from John Stuart Mill (1889, chapter XI and the Appendix).

<sup>33</sup> Husserl already pointed out that causal relevance is an important feature that marks a difference between *res extensa* and *res* in the sense of material object (1952, §16). See also Heider, who suggests classifying environmental objects according to their causal relevance (1978).

<sup>34</sup> I name such objects quasi-stuffs (Soentgen 1997a, Section 21).

<sup>31</sup> The example is taken from Schopenhauer (1949, 342).

least two very different types of dispositional predicates: suitability (*Eignung*) and tendency (*Neigung*). In accordance with Leibniz, I understand suitability as a passive possibility and tendency as a positive (active) possibility.<sup>35</sup> Both suitability and tendency are realisable dispositions. The cause of the realisation is *external* in the case of suitability and *internal* for tendencies. Salt is *suitable* for seasoning food. But the tendency for salt to form cube-like crystals comes *from salt itself*: this is its tendency. This is something which salt, given suitable conditions, does by itself; at least it is in our commonsensical reasoning, which we attribute to the spontaneous behaviour of the salt itself.

My claim is that all stuffs have tendencies. They are not merely neutral masses, which we can fit into our plans of action in some way or another. They are themselves active units, in that they create distinct forms, such as crystals or fractal structures, and in that they interact with other stuffs, dissolve or react chemically. Even the most inactive stuffs known, the inert gases, have tendencies; in particular the tendency of mixing, which sometimes makes experimenting with these stuffs and keeping them clean difficult.

*Stuffs can be found at the same time in different places*

Whereas a single object such as a human being or a cherry can only exist at a certain time in a certain place, a stuff exists spread throughout the world in various locations.<sup>36</sup> The fact that a certain stuff, e.g. salt, can be found at different places at the same time has led to the opinion that stuffs might be scattered object. Thus, an approximation between the concept of a thing and the concept of stuff seems possible. It might even seem that the concept of stuff can be reduced via the idea of “scattered things” to the concept of thing. However, this isn’t the case, as has been pointed out by the phenomenologists. The way we find scattered things is different from the way in which we find samples of a stuff. Albert Grote points out:

Even if I gather all quantities of a certain stuff in front of me, it would become a big amount of the stuff, but would not be the stuff as such. A proposition like ‘this is the stuff iron’ does not have an enclosing sense and does not mean a quantitative fixation. In contrast to sentences like ‘this is the Montblanc’ the stuff iron isn’t being encompassed, but qualitatively exemplified. (Grote, 1948, 245)

Individual things exist for a certain time, then they cease to exist. Stuffs don’t disappear in the same way. They cease to exist in a different manner than individual things. Their occurrences can be exhausted.

We can ask where and how a stuff occurs (abundantly or rarely) and the information that we receive by so doing is information about the *stuff*. The stuffs are not statistically delocalised. On the contrary, stuffs form in the course of complex chemical

<sup>35</sup> See Leibniz (1882, 155): “On peut donc dire que la puissance, en general est la possibilité du changement. Or le changement ou l’acte de cette possibilité, estant action dans un sujet, et passion dans un autre, il y aura aussi deux puissances, passive et active. L’active pourra estre appelée faculté, et peut estre que la passive pourroit estre appelée capacité ou réceptivité.” See also Leibniz (1992).

<sup>36</sup> The traditional philosophical concept, universal (general object) covers this state of affairs. The century-old debate about this concept is very complex and cannot be treated here. See Aaron (1967) and Bigelow (1998).

processes; they are spread over the earth’s crust and collect in sedimentary processes in “pockets,” recesses, veins, crevices and other places.<sup>37</sup> They are spread out according to their tendencies: The statement “stuffs can be found at the same time in different places” is connected to the statement “stuffs have tendencies.” On the other hand, this statement evidently is connected with the first one, that stuffs can be cut into portions.

*There are stuffs that are natural kinds*

Differentiating between natural and nominal (artificial) kinds is actually an old point of discussion, such as can be found in Leibniz’s *Nouveaux Essais*.<sup>38</sup> The analytical philosopher Saul Kripke has renewed the discussion in his study about proper names and taken stuffs also into account.<sup>39</sup> An essay of Hilary Putnam also has been very influential in various domains of analytical philosophy (1975). These contributions made stuffs, especially gold and water, famous again as natural kinds. Since the discussions of John Locke and Gottfried Leibniz these two stuffs have been the most popular examples in philosophical discussions on kinds. This is quite natural, as they represent a symmetric choice: Water is the stuff which is physically of the highest value, while gold is the stuff which is most appreciated in social interchange.

Jaap van Brakel has delivered a brilliant survey of the complex discussion on kinds and natural kinds.<sup>40</sup> Since Husserl’s discussion of nominalism in his *Logical Investigations*, natural kinds have also been an ongoing object of phenomenological research. Hans Lipps then was the first one in this tradition to speak of stuffs (like iron) as of kinds; his opinions and arguments were amplified by Albert Grote. On the basis of a comprehensive investigation of the historical discussion of universals and kinds, the phenomenologist Hermann Schmitz offered a complex concept which he endorsed with an extensive discussion of Plato’s and Aristotle’s views on kinds (Schmitz 1980, § 263-268; 1985).

What is a natural kind? A natural kind is an object which occurs in the explained sense, i.e. which can exist simultaneously in various places. Concerning the distinction between natural and nominal kinds, I suggest the following tentative distinction: A natural kind is a unity that exists in nature, while a nominal kind is a unification which has been installed by men for certain purposes. John Stuart Mill formulated a useful criterion for explaining this distinction: There are, he states, endless properties common to all members of a natural kind, that don’t follow logically from the features by which we pick them out as members of this kind (Mill 1973, vols. 7, 8, 122ff).<sup>41</sup> Typical nomi-

<sup>37</sup> See Petrascheck (1970) and Schöenberg (1973); cf. Fischer (1961).

<sup>38</sup> In his critical examination of John Locke’s *Essay concerning Human Understanding* (Book II, chapter XXIII) Leibniz shows that “gold” refers to a stuff, i.e. a natural kind, and not to connections of elementary ideas, which are collected by ourselves (Leibniz 1882, livre III, chapter VI).

<sup>39</sup> See Kripke (1993). Through this work the idea has become popular with the analytical philosophers. Kripke refers to John Stuart Mill as another defender of natural kinds; cf. Mill (1925, Book I, chapter VII, §4): “Kinds have a real existence in nature.”

<sup>40</sup> See van Brakel (2000), esp. chapters 2.5, 2.6 and 4. See also Hackers’ critique of Putnam in Hacker (2004).

<sup>41</sup> Cf. the similar remarks of Carl Gustav Hempel: “The rational core of the distinction between natural and artificial classifications is suggested by the consideration that in so-called natural classifica-

nal kinds are, for example, statistical entities or negative classes such as non-aqueous liquids or inorganic compounds, which include all compounds that don't contain carbon with the exception of CO<sub>2</sub> and carbonates. Such classes of stuffs have important functions in chemical research, but they don't refer to natural kinds. Alcohol and quicksilver virtually have nothing more in common than the fact that they are non-aqueous liquids. Thus, the name non-aqueous liquid doesn't refer to a natural kind but to a nominal kind.

There are stuffs that are natural kinds. How otherwise could certain stuffs have properties that nobody had expected, that nobody had even thought of, indeed that nobody had believed in, if they hadn't been convinced by seeing them with their own eyes? Something which is only an abstract entity would hardly be as surprising as the discovery of phosphorous by the alchemist Henning Brand. He was very taken aback when he observed that the stuff he had discovered shone in the darkness.

If all stuffs were mere nominal kinds it would be difficult to understand why our body reacts very precisely to certain stuffs. If we are thirsty, we look for water. If someone has a nickel-allergy, he will break out in a rash if he wears trousers with nickel-rivets, irrespectively of his knowledge of their presence.

The adjective "natural" in the statement doesn't imply that it isn't possible to synthesise stuffs in the laboratory which don't occur in nature. It would be absurd to want to make use of the different nominal/natural kinds to cover the difference between synthetic materials and natural stuffs.

After having defended my opinion that some stuffs are natural kinds, the question remains to be discussed whether all stuffs are natural kinds. In our commonsense-world they are not. There are denominations of stuffs, which evidently don't refer to a natural kind but to a nominal kind: For example dyestuff, lubricant, filling material, construction material or poison. Yet, if we were asked to show a prototype of a stuff, we would not refer to a mere nominal kind, saying for example: "A filling material is a stuff." Instead, we would think of a natural kind, most frequently water or cotton or a piece of wood. Thus, the knowledge that there are natural kinds of stuffs is rooted in our commonsensical notion of stuffs.

#### *The definition of kinds of stuff*

Distinguishing kinds of stuff is an everyday necessity; and even animals are able to distinguish one kind of a stuff from another. The need to define kinds of stuff generally only rises in the context of professional work. Merchants, carpenters, tailors, bakers, metallurgists, stone-cutters, etc. need to have good definitions of their stuffs to do their work properly. (The question of how to define "stuff" as such arises in contrast only in situations of philosophical reflection.)

What methods exist to define kinds of stuff? Many stuff kinds can be defined using chemical formulas. This situation has led to a certain essentialisation of the chemical formula, to the opinion that every stuff "has" a formula and that stuffs, which cannot

tions the determining characteristics are associated, universally or in a high percentage of all cases, with other characteristics, of which they are logically independent" (1952). Cf. also Ian Hacking (1990, 129-141).

be described using a formula, are not proper natural kinds, but merely mixtures. Occasionally we even read the claim that a chemical stuff can be completely described using its chemical formula. Both views overestimate the instrument of the chemical formula.<sup>42</sup> It is important to recognise that there are limitations to the possibilities of describing stuffs with formulas. "Possessing formulas" isn't a characteristic of kinds of stuff. Formulas are nothing more than elegant methods of description, which can be used to represent some properties of stuffs satisfactorily. Therefore a stuff which can't be represented by a formula is in no way to be regarded as an inferior member of the family of stuffs.

On the other hand, not even the purest preparations can be described satisfactorily using their structural formula. Already in the 1920s the physical chemist Johannes Diderik van der Waals pointed out that distilled water could not be completely characterised using the notorious "H<sub>2</sub>O." Various other molecules and molecule clusters occur even in the purest water (van der Waals, 1927, 227-235). Moreover there are also some stuffs which are not identical although they share the same chemical composition. This is the case with ceramics, which, despite the fact that they may have the same basic composition, often differ in respect to their properties due to their production processes. Another example of chemically equivalent, yet macroscopically different, stuffs are the metal-meteorites. Although we know their exact chemical structure, they have a property which distinguishes them from all synthetic alloys with exactly the same chemical composition which metallurgy can produce: They show the so-called "Widmanstätten-Figures." These figures also occur on a microscopic scale in "normal" alloys. However they cannot be created in a laboratory on a macroscopic scale, they only come into being if a material is exposed to the conditions of outer space for a very long time.

In addition there are many stuffs to which a chemical formula cannot be attributed such as highly polymerised stuffs or alloys. In such cases we are able to provide alternative descriptions, such as describing the origin or the production process, or by using a phrase with identifying markers. Such descriptions can characterise the stuff satisfactorily so that it can be identified as a certain natural kind at any time.

A formula isn't the *principium individuationis* of stuffs. It isn't the essential feature, which makes a stuff *this particular stuff*. Thus, the inventor of the rubber (caoutchuc)-synthesis, the chemist Fritz Hofmann, was not sure whether his product was true rubber or not when he held the first result of his new synthesis in his hands in the summer of 1909. He had to visit the rubber-technician, Dr. Gerlach in Hanover. The specialist checked the probe and identified it: "Your synthetic product is very similar to a certain kind of natural rubber, the so-called negro-heads, a commodity that is produced in the region of the Congo. This isn't the best class of natural rubbers, but still it is rubber!" (Butze 1955, 74)

Fritjoff Hirsch, a lawyer and chemist working as a judge at the Federal Court for Patents (*Bundespatentgericht*) in Munich, has to deal professionally with defining stuff types. He summed the situation up as follows:

<sup>42</sup> For an exposition of the development and logic of chemical formulas, see Bradley (1990).

Usually stuffs with the same chemical composition can be regarded as being identical. However, the possibility cannot be excluded that two stuffs with the same molecular structure may be two separate individuals, if there are differences between them based on reliable parameters. A difference in form, such as a particular differing macrostructure, between stuffs with the same chemical composition, as in the case of polymer stuffs, can lead to differing physical properties of the stuffs.<sup>43</sup>

Thus the chemical formula is “only one method among others to reach a definition of a stuff. The fact that the formula is usually the best definition doesn’t exclude other definitions” (Hirsch 1980, 47).

Similarly, the philosopher Jaap van Brakel criticises the thesis which has been introduced into the analytical discussion by Kripke and Putnam, that “water is H<sub>2</sub>O”: “Perhaps Locke was wrong to say that we cannot know ‘underlying’ properties..., but it doesn’t follow that the microproperties have a higher status metaphysically speaking, even if they have wildly heuristic value” (van Brakel 2000, 118). He holds that microproperties are not essential properties, and that all essential properties are always related to our knowledge or way of looking at the world (118). In the tradition of Wilhelm Ostwald, he suggests macroproperties like melting point and other thermodynamic data to define a kind of stuff. Yet these methods only apply to chemical stuffs and, as van Brakel himself notes, only to a part of them (chapter 3.4). Yet there are more natural kinds of stuffs than there are chemical stuffs. How can they be defined? A very common kind of definition applying especially to foods and drinks is, for example, according to their (geographical or biological) origin.

Also in the sciences, the chemical method of definition, although central, is not the only one. Stones for example are defined primarily on the basis of their geological properties, in particular with respect to their geological genesis (magmatic stones, metamorphic stones, sedimentary stones) and on the basis of their geographical origin. The chemical composition of a given stone-kind may differ in certain degrees—but the geological process, which produced the stone, is essential for its definition. There are stone-kinds, which have the same chemical composition, but are nevertheless different kinds of stones because of their different geological prehistory.<sup>44</sup>

In mineralogy, there are certain requirements for mineral species, as the “IMA [International Mineralogical Association] Commission on New Minerals and Mineral Names” states: “A mineral stuff is a naturally occurring solid that has been formed by geological processes, either on earth or in extraterrestrial bodies” (Nickel and Grice 1998, 3). Anthropogenic stuffs, i.e. those made by man, are explicitly excluded from the definition. Not only is the chemical composition relevant for the definition of the kinds, but also the crystallographic properties. Minerals with the same chemical composition, but different crystal structures, are different kinds. This is also the case if, in a given mineral, regular interstratifications of two or more minerals exist. Thus, although

<sup>43</sup> Hirsch (1980, 46). For a description of the difficulties in defining minerals using chemical formulas, see Tatje (1990, 28-35).

<sup>44</sup> Entry “Gesteinsarten,” in Albrecht Germann, Ralf Kownatzki, Günther Mehling, eds. *Naturstein-lexikon* (München: Verlag Georg D. W. Callway, 2003).

mineralogy is tightly linked to chemistry—indeed both disciplines share a common history—we find that kinds, which are regarded chemically as the same kinds, are regarded from the point of view of mineralogy as different. Moreover, a chemist would call some kinds of the mineralogist mere nominal kinds. “Why,” he may ask, “should we make a distinction between manmade minerals and minerals which occur in nature?”

This restriction makes sense: The mineralogist is interested in geological questions, therefore he has different criteria for the definition of a kind of stuff in his field as compared to the chemist. Furthermore he also has other criteria for the identity of his natural kinds: If a chemist resolves a piece of chalcantite (copper-vitriol) in water and allows it to crystallise again, it is still the same stuff. But if a mineralogist goes to his collection of minerals, takes a piece of chalcantite, puts it into a glass of water and later allows it to crystallise again, it is no longer chalcantite, but mere copper-vitriol. He has transformed a mineralogical species into a chemical one.

We see that there are several ways of defining natural kinds of stuffs and of defining the identity of a certain kind of stuff. Chemical descriptions (formulas) play a central role nowadays, yet they are neither necessary nor are they always sufficient for the definition of all the kinds of stuff which are distinguished by man. In certain contexts (stone cutting, mineralogy, etc.), origin or the production process or other features may deliver definitions which are similarly precise and useful. The fact that certain professions distinguish natural kinds, which are essentially identical from a chemical point of view, should not lead to the conclusion that these natural kinds are in reality mere nominal kinds. Although it is possible that some natural kinds turn out to be merely nominal, as may be the case with commercial names of granites which have a different name but exactly the same appearance, we should develop an open attitude to all ways of distinguishing natural kinds. As chemistry cannot be reduced to physics, mineralogy cannot be reduced to chemistry. Likewise professional or everyday practices cannot be reduced to scientific ones. Before mucking about seemingly useless definitions of natural kinds we should try to understand them. We may learn to see something in a new way.

### Summary

In my opinion the definition above applies to all stuffs, and it applies *only* to stuffs. Each individual point is necessary, and the six points together are just enough to distinguish between stuffs and non-stuffs. There is a test to prove this claim. Every entity, which we call “stuff” also fits all the sentences listed above. Warmth for example, is not a stuff, because it can’t be portioned and it isn’t material in the sense explained. Nevertheless, the definition does not allow a completely sharp distinction, as I have already mentioned. There are prototypes for stuffs—for example wool, water, gold, butter—but there are also borderline cases.

One interesting and important borderline case is air. As Husserl already observed, and the perceptual psychologist Fritz Heider and his school worked out, air is generally

categorised as a medium, something negligible between us and objects.<sup>45</sup> Air is only under certain circumstances seen as a stuff in our everyday world/environment. These circumstances are especially experiences under water, if we see bubbles in a whirlpool or if we create soap-bubbles. Only in these (and a few other) special occasions, do we experience air as a stuff, which can be portioned, which produces typical forms, which has tendencies, etc. In other words: air can appear as a stuff, but generally it is perceived as a medium in our everyday world. This example may show that the definition indeed has blurred margins.

None of the elements of my definition is in itself new. On the contrary, some of them are even subject to intense philosophical discussions; for example the point that "There are stuffs that are natural kinds." The value of my study will not only be found in critical phenomenological revision, but also in its synoptical power. The definition isn't just a coincidental collection of arbitrary criteria. On the contrary, the individual points are connected and they explain each other.

"Stuffs occur at the same time in different places"—because they can be divided into portions and have specific tendencies. They can be divided into portions because they are material. Their tendencies and suitabilities are a strong motive for us to distinguish natural kinds of stuffs. Yet there seem to be two sentences listed above which appear to contradict each other: "Stuffs can be cut into portions" and: "Stuffs display characteristic structures." On the one hand I claim that portions are parts which contain the entirety, and on the other hand I claim that each divisional process results in a new structure. How can these two claims be true at the same time? Indeed, there is a certain tension. Maybe this tension is due to a too-superficial analysis. This is possible. It is also possible that our everyday concept of stuff includes certain tensions and it is exactly for this that it is useful.

I would like to remind the reader that the structured forms which emerge when we break, for example, a piece of chalk (or divide another stuff) are always of the same type. As such, they are characteristic for a certain stuff. Even if we create new structures when cutting a stuff into portions, we expect that these structures resemble each other. If they don't, we no longer speak of portions of the same stuff, but use new names to denote the result of our divisions. If we cut an opal into such fine pieces that the typical play of colours vanishes, we no longer call the result pieces of opal, but we would say: "This was once an opal." If we divide a gram of sand into single grains of sand, we no longer call these grains sand, but speak of grains of quartz or olivine or limestone. The grains show their own structural forms (under the microscope) and are another stuff. Thus I don't see any serious contradictions between the point that stuffs can be cut into portions and the point that it displays characteristic structures.

The fact that the individual sentences are not "hanging isolated in the air" but that they point to each other seems to support the opinion that this description probably defines the category of stuff. The description given here is in the form of a definition.

<sup>45</sup> Husserl (1952, Supplement to §16); Heider (1927, 109-157). Heider's works on the perception of media have been continued by Gibson (1979), part 1, 2: "Medium, Stuff, Surfaces," especially 16. To the phenomenologist Schmitz, air is neither a stuff nor a medium, but a mere "construction" (2003, 99-112).

This is not to provide a useful instrument to distinguish between stuffs and non-stuffs for technical purposes. Such problems of differentiation occur too seldom to motivate such a detailed study as this one. On the contrary, the description given here seems to stimulate an understanding of stuffs. It seems that stuffs, which we consider to be inanimate, are more similar to animate beings than we think. Stuffs are not inorganic in the sense of having no form, being eternal, continuously determined or languid. They are not merely neutral, faceless space-fillers.

The suggested definition asks for more elaboration. It has to be set in the context of further stuff-related concepts. Thus it would be profitable to critically reconstruct those concepts with which we describe stuffs (de Vos 1995): What is the difference between a reaction and a mixture? What do we mean when we say that a stuff melts, vaporises, freezes, etc.? A phenomenological description of stuff-related processes could also equip the concept of stuffs suggested above with a more detailed background. Above all, it can be expected that the existence of an autonomous dynamic in stuffs could be made even clearer, just as in animate beings.<sup>46</sup>

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