

Yet Another Taxonomy of Part-Whole Relations

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Abstract. We propose a taxonomy of part-types based on the manner of attachment of a part to the rest of its parent whole, its degree of dependence on that whole or on external factors, and the temporal relation between its being a part and its being described as such.

Keywords. part-whole relations, dependent and independent parts, attachment

1. Introduction

Amongst existing classifications of parts and wholes we may distinguish two broad approaches. On the one hand there are formal mereologies, which typically embrace unrestricted summations and subdivisions, operating with a generalised notion of parthood which does not commit to any distinctions between kinds of parts other than proper vs improper parts and, in some systems, atomic vs non-atomic parts. On the other hand we find more nuanced approaches, typically motivated by cognitive or linguistic considerations, in which distinctions are drawn amongst an apparently disparate range of relations to which the term ‘part’ has been applied. Such approaches may distinguish, for example, between, *inter alia*, functional and spatial parts [3], or between components and portions [7]. Often included here is membership of a collection, and this is notable in that typically the members of a collection are spatially separated, whereas, for example, the components of an artefact are usually spatially contiguous. It is this aspect—the nature and extent of the spatial connections amongst the parts of some whole—on which the new taxonomy proposed here focuses; this constitutes a dimension of variation amongst different kinds of parts that has been comparatively neglected, yet is one that is clearly of considerable significance in our day-to-day deployment of the parthood concept. The closest existing work I have found to this approach is that of [6], though whereas that paper is concerned exclusively with parts of artefacts, my taxonomy is intended to be more broadly applicable.

The taxonomy proposed here is more narrowly focused than many, being concerned only with material objects and their material parts; and concerned with the latter primarily in respect of the nature of their attachment to the whole of which they are parts, and their degree of dependence thereon: but these aspects are considered in perhaps greater detail than is usually found in existing taxonomies.

2. Motivating discussion

Our starting point is the notion of a *unitary whole*, which consists of some (possibly variable, possibly heterogeneous) quantity of matter configured in such a way that, at an “everyday” (mesoscopic) level of granularity, it occupies a connected region of space, is bounded by a complete closed surface, and ‘hangs together’, i.e., retains these properties continuously over a sufficiently extended period of time. Examples include the computer on which I am typing these words, the table it is resting on, the chair I am sitting on, my bicycle and, indeed, me myself.¹ A *complex* comprises two or more unitary wholes which somehow “belong together” without necessarily together forming such a whole. An *independent whole* is either a unitary whole or a complex. For brevity I shall often abbreviate this to ‘whole’ except where it is important to stress its independent nature.

An independent whole may have various kinds of *parts*, which may or may not be independent wholes in their own right. I call the whole of which a part is a part its *parent whole*, where ‘parent’ is not, of course, to be understood in a generational sense. In the taxonomy we distinguish between dependent and independent parts. Many artefacts are brought into existence by assembling together, in a particular way, some collection of independent parts: such artefacts are *assemblies*. A bicycle, for example, is assembled from a definite number of independent parts; these are organised hierarchically, in that some subcollections of the parts form *subassemblies*—themselves independent parts—such as each of the wheels, whose parts include rim, spokes, hub, tyre, and inner tube. The truism that “the whole is greater than the sum of the parts”, properly interpreted, means that the properties of the whole do not depend solely on the properties of its individual parts, but also on how they are put together to form the whole.² Independent parts retain their character as wholes even in the context of the composite whole of which they are part. Assemblies can typically be disassembled, without severing connections, and put together again; hence independent parts are generally *replaceable*.³

Many wholes do not have independent parts. This is necessarily true of the smallest independent parts of an assembly: a single spoke of a bicycle wheel is just a long thin cylinder of metal, all one piece. It is also very nearly true of most living organisms—indeed, an important difference between organisms and artefacts is that the parts of the former are typically dependent, those of the latter very often independent. None of my internal organs or external appendages is an independent whole. Both head and heart are joined seamlessly to the rest of the body, neither of them bounded by a closed surface. Since they are not independent parts of the body, but are evidently parts, we call them *dependent parts*. And since they are distinguished by means of rather natural, non-arbitrary criteria—which may relate to, amongst other things, geometry, material, or function—we call them *intrinsic dependent parts*. Living organisms typically have many intrinsic dependent parts, but some wholes have no such parts. A uniform metal sphere offers no intrinsic inhomogeneities for any distinction of parts to gain purchase.

¹The term *integral object* has often been used in the literature—but depending on the author, this term may or may not refer to the same thing as what is here called a unitary whole. The difficulties inherent in pinning down these concepts are explored in Chapter 9 of [5].

²If one regards this structure or configuration as a part in its own right (but not, of course, a material part), then the whole is precisely the sum of its parts; this is a view that has been advocated by Koslicki [4], but I shall not follow it here.

³Simons and Dement [6] provide an insightful analysis of the mereology of artefacts.

As already suggested above, there are several different ways of distinguishing dependent parts, for example:

- *Geometrical*. If a strip of metal is bent in two to form a right angle, then the two “arms” thereby formed are distinguished dependent parts of the resulting whole.
- *Material*. A fingernail is distinguished from the rest of the finger by its different material composition. Note that it is not an independent part: the only way of removing the fingernail is by severing connections to form new surfaces.
- *Functional*. A wine glass has three functionally defined distinguished dependent parts: the bowl (for containing the wine), the stem (for holding the glass), and the base (for resting it on the table or other flat surface).⁴

As already hinted in the footnote, these criteria often work together: functional distinctions typically depend on geometrical or material distinctions.

Sometimes we want to refer to a part of some whole even when there exists no “natural” basis for distinguishing it from the remainder of the whole. This is what happens if I trace an outline on a pane of glass and refer to the part of the pane enclosed by the outline. That “part” only exists, as an object, insofar as I have designated it. Such parts will be called *designated parts*. They are *extrinsic* because they depend for their existence on some external means of designating them. A part may be *retrospectively designated* by being detached from its parent whole, thereby becoming a whole in its own right. Referring to the time before separation, we might now say that it was a part then, even though the designation on which it depended had not yet occurred. Retrospectively designated parts have only a tenuous claim to existence.

Michaelangelo is famously reported to have said that “every block of stone has a statue inside it and it is the task of the sculptor to discover it”.⁵ But from a commonsense point of view, before Michaelangelo began carving the *David*, the matter which later constituted the *David* did not constitute any object. Note that this flies in the face of the principle of unrestricted mereological fusion embraced by most formal mereologies, according to which the existence at the earlier time of the atoms that would subsequently make up the *David* implies the existence of an object composed precisely of those atoms, namely their mereological sum. As has often been pointed out, this leads to a highly profligate ontology which requires the existence of innumerable entities that not only do we never refer to, but we never *can* refer to.⁶

3. The Proposed Taxonomy

The taxonomy is shown diagrammatically in Figure 1. For expository purposes it is convenient to begin the discussion at the second division of the hierarchy rather than the first.

1. **Independent part**. A part which is itself an independent whole, such as the frame or a wheel of a bicycle. Types of independent parts are

⁴Of course, these parts can also be distinguished geometrically, but their *raison d'être* is primarily functional.

⁵*Ogni blocco di pietra ha una statua dentro di sé ed è compito dello scultore scoprirla*. Although widely cited, I have been unable to find the original source of this.

⁶Think of all the other possible sculptures, good, bad, or indifferent, which could have been carved from the block instead of the *David*—on one understanding of Michaelangelo’s conceit, they were all *already there*.

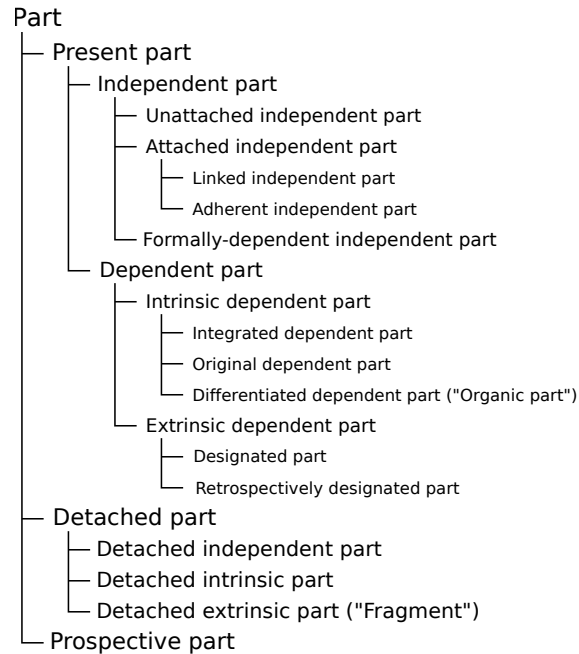


Figure 1. Taxonomy of part-types

- (a) **Unattached independent part.** An independent part which is not attached to any other part of its parent whole. E.g., any of the pieces of a multi-piece object, such as the lid and body of a saucepan, the mattress and base of a bed, the top and bottom of a bikini. Unattached independent parts may or may not be in contact with the rest of their parent whole; in the case of a saucepan, it is an essential part of its functioning that the lid can both be separated from the body of the pan and sit tight over the opening.
- (b) **Attached independent part.** An independent part which is attached to at least one other part of its parent whole. We distinguish two cases, depending on the nature of the attachment:
- i. **Linked independent part**, in which the attachment is by contact, without adhesion, e.g., all the independent parts of a bicycle. This kind of attachment is typically accomplished by some kind of interlocking, e.g., the screw top of a jar or bottle, or by means of a connector such as a screw or nail. Typically, a linked independent part can easily be detached, thereby becoming an unattached part (as when the bottle-top is unscrewed).
 - ii. **Adherent independent part**, in which the attachment is by some form of reversible (non-disruptive) adhesion, as with many forms of glue. The part retains its full surface, part of which adheres to the rest of the parent whole by means of the bonding agent. In principle the part can be unattached without damaging it (e.g., by dissolving the glue).
- (c) **Formerly-dependent independent part.** An originally dependent part which has become independent by the severing of connections with the rest

of its parent whole, while remaining part of that whole. This is a somewhat *recherché* category, but there are some reasonably commonplace examples:

- A human club hair—this is a hair in the *telogen* phase, when it has stopped growing, the blood vessels connecting it to the follicle having atrophied and a new surface formed at the base; it remains linked to the body because the club-shaped base is held in place by the narrow aperture of the follicle.⁷
- Blood cells, which originate as dependent parts of the bone marrow; they remain joined to the rest of the body via the blood plasma, which being liquid allows the cells free movement while remaining parts of the body.
- The blocks of stone formed by erosion of a granite tor, which remain in place as parts of the tor even though no longer attached to each other.⁸

This subcategory cuts across the other subcategories of independent part: any formerly-dependent independent part must already belong to one of the other subcategories. A club hair, for example, *is* a linked independent part; the stones in the tor are unattached parts.

2. **Dependent part.** A part which is not an independent whole, its matter being continuous with that of the rest of its parent whole and therefore lacking a complete closed surface of its own. The boundary of a dependent part, where it does not coincide with a surface or other physical discontinuity, is typically somewhat indeterminate in location. Types of dependent parts are:

(a) **Intrinsic dependent part.** A part distinguished by any (or several) of a variety of intrinsic factors such as geometry, material, texture, or function. From a cognitive point of view, some combination of such factors often results in the part so distinguished possessing a characteristic affordance. Types of intrinsic dependent part include:

- i. **Integrated, or formerly-independent, dependent part,** arising when an independent whole becomes integrated with other parts making up the parent whole by an irreversible process of fusion involving the destruction of part of the surfaces where they are joined (as for example in welding or brazing). Examples include the pieces of metal tubing that make up the frame of a bicycle; and the handle, spout, and body of an earthenware teapot.
- ii. **Original dependent part,** formed at the same time as the parent whole as a salient feature of it, e.g., the teeth of a comb, or the head of a statue that is cast in one piece or carved from a single block of stone.
- iii. **Differentiated dependent part,** formed during the growth of the parent whole: these are the body parts of living organisms, e.g., limbs, bones, internal organs, claws, horns, branches, leaves, etc., so long as these remain in situ. (These could also be called **organic parts**.)

(b) **Extrinsic dependent part,** existing as a part by virtue of some relation or interaction between the parent whole and its environment. We distinguish:

⁷Eventually the hair will be shed, either by being pulled out, e.g., during brushing, or by being pushed out by the growth of a new hair once the follicle resumes its activity (at the *anagen* phase).

⁸There are many examples of such tors on Dartmoor, in Devon, UK.

- i. **Designated part.** A part which exists only through being designated as such, typically by an act of human cognition, expressed verbally or by ostention, e.g., when someone traces an outline with their finger and says “this part”; or most geopolitical regions. In some cases nature itself can provide the designation, e.g., the part of an iceberg above the water.
- ii. **Retrospectively designated dependent part.** A part which only exists as a part by virtue of its subsequently becoming an independent object, e.g., that part of a certain block of marble comprising all the matter that later constituted Michaelangelo’s *David*. Retrospectively designated parts can only be referred to after they have ceased to be parts.

Extrinsic dependent parts in general do not have so strong a claim to being “real” parts as intrinsic or independent parts. We can say that an extrinsic dependent part is *part* of its parent whole, but not that it is *a part* of it.⁹

Independent and dependent parts may be called **present parts**, meaning that they are parts at the time they are so described. This constitutes one of the top-level divisions of the taxonomy. Sometimes, though, we refer to things as parts even though they are no longer, or are yet to become, parts of the parent wholes to which they are referred. These provide two more top-level categories for our taxonomy, as follows:

- 3. **Detached part.** An independent object that is not part of anything but which arose from the separation of a part from some parent whole. We distinguish:
 - (a) **Detached independent part**, e.g., a hub-cap from a car, found lying by the side of the road.
 - (b) **Detached intrinsic part**, e.g., hairs, teeth, bits of skin, leaves, fruit, pollen, etc, shed by a living organism. These originate as intrinsic dependent parts; but in some cases become independent parts before becoming detached.
 - (c) **Detached extrinsic part.** This covers bits broken or cut off something, e.g., a chip from a ceramic plate, a shard of glass from a shattered window pane, a branch sawn off a tree, a piece of hair cut from a human head, a slice of bread,¹⁰ a piece of cake. In many such cases, the parts that they formerly were are only retrospectively designated through the fact of their having been removed from their parent whole. Detached extrinsic parts are often called *pieces*,¹¹ though this word may also be used for unattached parts such as the

⁹Cf. Simons [5, p.235] — “the front half of a car, forward of some imaginary plane, is part of, but not a part of, the car”. Note that this distinction works in English, but I am informed by one of the reviewers that it is lacking in other languages such as German.

¹⁰Sometimes bread is sold ready sliced, the slices held together in a packet. In this case, rather than calling the slices detached parts of an originally intact loaf, one might rather describe them as unattached parts (specifically, members) of a collection of formerly-dependent independent slices.

¹¹“Suppose I take a hacksaw and cut a typewriter into two. Are the pieces I obtain ‘parts’ of the typewriter in the normal sense? Clearly not. In fact, the situation neatly differentiates the meanings of *piece* and *part*.” [1]

pieces of a jigsaw puzzle;¹² other words for detached parts include *bit*, *fragment*, and *slice*.¹³

4. **Prospective part.** An independent whole that is destined or intended to become a part of something, e.g., a handlebar for a bicycle or a heating element for an electric kettle, prior to installation. This applies to manufactured components before assembly into some artefact, and also to “spare parts”. In the case of prospective parts we typically speak of a part *for* something rather than *of* it; and whereas an actual part is always a part of some specific individual object, a prospective part is usually a part for a generic *type* of object (though in special cases a part may be manufactured for a specific “one-off” object, e.g., components produced as parts for some artwork). A prospective part may become either an independent part or a dependent part, depending on how it is incorporated into the whole. Because of the intentionality involved in characterising something as “destined” or “intended” to be a part, prospective parts do not occur in the natural world.¹⁴

4. Conclusion

The taxonomy proposed here is organised along rather different lines from most existing part-whole taxonomies, although many of the considerations advanced here have been previously noted. This taxonomy is advocated not as a replacement for any existing taxonomies but as providing a useful alternative perspective. In common with most cognitively-inspired taxonomies, the parthood relations discussed here may depart considerably from those found in typical formal mereologies, especially those which embrace unrestricted summations and subdivisions.

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¹²Cruse [2] suggests that the reason we call the elements of a jigsaw puzzle ‘pieces’ rather than ‘parts’ is that “the divisions are totally unmotivated with respect to the picture they go to make up”. This is related to his observation that the boundaries of pieces are ‘arbitrary’ whereas those of parts are not.

¹³Note that whereas “detached” implies “formerly attached”, “unattached” carries no such implication in general, though with a jigsaw puzzle its unattached parts were formerly attached since the pieces were produced by cutting up an original single object. But these are not detached parts in the sense intended here because they are still regarded as parts of the jigsaw puzzle, conceived as a complex of unattached independent parts.

¹⁴Though perhaps one could extend the definition to describe the haploid genome of a gamete as a prospective part of the diploid genome of a zygote which it may go on to form with a gamete of the opposite sex.