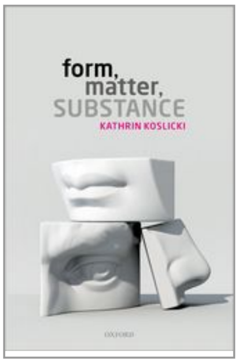

Form, Matter, Substance
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Unity

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Abstract and Keywords

A serviceable account of unity is needed which can capture the idea that matter–form compounds are more unified than other types of composite entities (e.g., heaps, collections, or mereological sums). This chapter develops a conception of unity according to which a structured whole derives its unity from the way its parts interact with other parts to allow the whole and its parts to manifest their “team-work”-requiring capacities. With this conception of unity in place, interesting differences emerge between paradigmatic matter–form compounds belonging to natural (e.g., physical, chemical, or biological) kinds and composite entities belonging to social kinds, in particular artifacts. In the latter case, the interactional dependencies that connect the components of a system can be traced to mind-dependent factors that are extrinsic or external to the system in question, viz., the mental states of intentional agents who invent, design, produce, or use an artifact.

Keywords: unity, structure, integrated wholes, natural kinds, social kinds, artifacts, interdependence, intentional agents, laws, capacities

7.1 Introductory Remarks

In Chapter 6, I argued that matter–form compounds, due to their composite nature, fail to be ontologically independent according to any of the construals of ontological dependence considered in Chapter 6. As a result, as long as the notion of substancehood *simpliciter* is approached through the lens of ontological independence, matter–form compounds will be excluded from the category of substances *simpliciter*. Despite their composite nature, however, matter–form compounds do deserve to count as ontologically privileged in other ways, since, among other things, they are more *unified* than other composite entities (e.g., heaps, non-empty sets, etc.). A unity criterion of substancehood thus holds more promise than an independence criterion to deliver the sought-after fundamentality ranking for composite entities, despite a general preference among Aristotelians for the latter. Since I take unity to be a comparative notion, the resulting notion of substancehood yields a *relative*, rather than an *absolute*, fundamentality ranking of (types of) composite entities based on their being *more or less* unified than other (types of) composite entities.

Our next job, then, is to develop a serviceable account of unity which allows us to make the required comparative judgments between more or less unified composite entities. In what follows, I propose a conception of unity which is inspired by and modifies an approach originally defended in Nicholas Rescher and Paul Oppenheim's "The Logical Analysis of Gestalt Concepts" (Rescher and Oppenheim (1955)). According to the modified account I offer here, what unifies a structured whole is not, as Rescher and Oppenheim have it, that its parts functionally depend on each other for the values they take with respect to their contingent physical attributes (since all physical systems meet this condition). Nor, as I argue in what follows, can the unity of structured wholes be said to be traced to the fact that their parts ontologically depend on each other for their existence, identity, essence, or real definition (since this requirement is not generally satisfied even by highly unified structured wholes). Instead, I propose that a structured whole derives its unity from the way in which its parts interact with other parts to allow both the whole and its parts to manifest those of their capacities that require "team work" among the parts. Interesting differences with respect to the source of their respective principles of unity will emerge between paradigmatic matter–form compounds belonging to natural (e.g., physical, chemical, or biological) kinds on the one hand, and composite entities belonging to social (e.g., artifactual) kinds on the other **(p.192)** hand. In the latter cases, we will find that the interactional dependencies that connect the components of a system can be traced to *mind-dependent* factors that are *extrinsic* or *external* to the system in question (e.g., the mental states of agents who invent, design, produce, or use an artifact).

7.2 Wholeness, Structure, and Unity

In Koslicki (2008a), I argue that we should conceive of wholes as structured entities, namely, in particular as compounds of matter and form, subject to the following restricted composition principle:

> (RCP^T) *Restricted Composition Principle*: Some objects, $m_1, \ldots, m_n$, compose an object, O, of kind, K, at a time t just in case $m_1, \ldots, m_n$ satisfy at t the constraints dictated by some formal components […], $f_1, \ldots, f_n$, associated with objects of kind, K.
>
> (Koslicki (2008a), p. 190)

I construe the constraints that are dictated by an object's formal components as primarily structural (see also Section 4.4.4.2):

> *Structural constraints*: Requirements concerning (1) the *type* or *variety* of material components; (2) their *configuration*, i.e., *manner of arrangement*; and, in some cases, (3) the *number* of material components of which objects of kind, K, may be composed.

I take (1) and (2) to be necessary conditions which must be met by an entity if it is to count as a whole and hence as structured. (3) is met only in some, but not all, of the cases in which an entity satisfies (1) and (2) (e.g., (3) is satisfied by H_2O molecules, but not generally by living organisms), and is therefore not a general requirement for an entity's status as a whole.

The restricted composition principle just cited carries with it a commitment to an ontology of kinds. For, according to (RCP^T), a plurality of objects is said to compose a whole of a particular kind, when the objects (material components) in question satisfy the selection requirements set by the formal components associated with wholes of that particular kind, i.e., requirements concerning, among other things, the variety, configuration, and sometimes the number of material parts out of which wholes of that particular kind may be composed. Such a restriction on composition, of course, only has plausibility if there are independent reasons for thinking that objects really do belong to kinds and that kinds really do pose constraints on the mereological composition of their members. In my earlier account, I assumed that the question of which kinds there are is not answered by the mereologist proper, but by the ontologist at large, in conjunction with considerations coming from other domains, such as science and common sense, which turn out to have something to contribute to the question, "What is there?" or, more specifically, to the question, "What *kinds* of objects are there?". For the special case of natural kinds, for example, our commitment to these kinds is typically **(p.193)** supported by an appeal to their role in prediction and explanation; particularly noteworthy in this respect is the weight borne by *scientific* natural kinds (e.g., physical, chemical, and biological kinds) in (i) inductive reasoning, (ii) the laws of nature, and (iii) causal explanations. Once such independent, extra-mereological reasons for believing in the existence of a certain kind of object have been given, we find in general that objects must satisfy more or less stringent mereological constraints in order to count as instances of the kind.

Given this account, can we link up structure and unity in such a way that a whole counts as unified just in case it is structured, i.e., in the sense specified by (RCP^T) together with (1) and (2)?[1] In that case, a whole would be unified just in case it satisfies the structural constraints imposed by its formal components governing the variety of material components of which wholes of the particular kind in question may be composed as well as the configuration exhibited by these material components.

But according to (RCP^T) mereological composition only occurs in the first place when the conditions specified in this principle are met. Therefore, according to this approach, all entities which qualify as wholes at all would be classified as both structured and unified, and as unified to the same extent, since in order for something to be a whole at all (i.e., in order for mereological composition to take place successfully) the entity in question must be structured in the sense specified by (RCP^T) in conjunction with (1) and (2). I will refer to this proposal as (WSU), short for "Wholeness = Structure = Unity." As it stands, then, (WSU) apparently does not make room for the possibility of wholes which are less unified than matter–form compounds. Where does this leave us with respect to other types of composite entities which are apparently less unified than matter–form compounds (e.g., heaps, non-empty sets, committees, and the like)?

If we link up wholeness with structure and unity in the way indicated by (WSU), non-empty sets, for example, can be classified as non-unified, because they lack the kind of structure required by (RCP^T) together with (1) and (2). We cannot in any meaningful sense attribute formal components to non-empty sets whose job it is to place constraints on these entities which govern the variety and configuration of constituents of which they may consist. Assuming that a non-mereological construction operation (viz., set formation) is involved in "building" sets from their members, the question of whether sets exist does not hang on whether the set-building operation satisfies (RCP^T), in conjunction with (1) and (2). Still, (WSU) yields a way of categorizing non-empty sets as non-unified, since they fail to satisfy the structural constraints specified in (1) and (2). On the assumption, then, that an entity must exhibit the sort of structure required by (1) and (2), in order for it to count as a whole and as unified, non-empty sets would fail to qualify for this status.[2]

(p.194) Heaps constitute an interesting intermediate case: while they fail to satisfy the first structural constraint (viz., variety), they do at least in a loose way meet the second structural constraint (viz., configuration).[3] Few, if any, type restrictions govern the constituents from which heaps may be formed: in principle, one may pile almost anything on top of anything; and, if there are restrictions, they seem to be of a more practical, rather than metaphysical, nature. But there are some configuration requirements which a plurality of objects must satisfy in order for these objects to form a heap, viz., they must at least be arranged in certain spatiotemporally proximate positions so that the overall result of their arrangement has the approximate shape of a heap. In this way, heaps are somewhat more structured than non-empty sets, say, but less so than matter–form compounds. The proposal currently under consideration thus opens up a way of assigning an intermediate status to heaps which would place them between matter–form compounds on the one hand, and non-empty sets on the other hand, since they satisfy some, but not all, of the structural constraints which would confer on an entity the highly unified status characteristic of matter–form compounds. Heaps do not quite make it into the (WSU) category; but they come closer to doing so than non-empty sets do, since they at least satisfy one of the two structural requirements an entity must satisfy for full (WSU) status.

Not surprisingly, natural matter–form compounds meet the criteria necessary for inclusion into the (WSU) category with flying colors. For Aristotle, the contrast between heaps and natural matter–form compounds comes down to whether an entity's constituents are held together by an internal principle of unity whose presence in the object is due to nature, rather than art. In the case of a heap, the constituents (e.g., the sticks in a bundle) are held together, if at all, only by an external and artificially imposed principle of unity (e.g., a band tied around the bundle of sticks). But the principle of **(p.195)** unity, in this case, is not one which is internal to the bundle of sticks or which arises naturally from the sticks in the bundle; rather, it is an element that is added to the sticks, by art rather than by nature, for the specific purpose of giving some cohesion to the bundle of sticks which it would otherwise lack. In this case, the principle of unity (the band) which holds together the remaining constituents (the sticks in the bundle) belongs to the same ontological category as the constituents on whom it confers cohesion. If the category of matter–form compounds includes artifacts, then each of the constituents of the heap would already in itself count as more highly unified than the entire constellation into which these constituents enter when they form a heap. The case of artifacts will concern us in more detail in this chapter and Chapter 8.

In contrast, at least in the case of natural matter–form compounds, the unity of the whole, in Aristotle's view, can be traced to the presence of a principle of unity (its form) that is both natural and internal to the matter–form compound. In this case, the form, which acts as the principle of unity for the matter–form compound, belongs to a different ontological category from that occupied by the material parts it serves to unify. As empirical evidence for the unifying power of form in natural matter–form compounds, Aristotle points, for example, to the contrast between the body of a living organism and the corpse it leaves behind. While the organism is alive, its form, viz., the soul, holds together the organism's body and the material parts which are present in it only potentially. But after the organism has died, the corpse it leaves behind slowly begins to decay and disintegrates into the multiplicity of material constituents which are now actually contained within the corpse. With no soul present in it to act as principle of unity, there is nothing to prevent the earth, air, fire, and water which actually compose the corpse, in Aristotle's view, from slowly separating from each other, following their natural tendencies.

Thus, based on the considerations rehearsed so far, (WSU) already allows us to establish at least the following ranking among composite entities with respect to the extent to which they are unified:

Natural matter–form compounds: highly structured and unified wholes which satisfy both (1) and (2).

Heaps: entities that have constituents, but are less highly structured and unified than matter–form compounds; they do not satisfy (1) and satisfy (2) only in a loose and undemanding way.[4]

(p.196) *Non-empty sets*: entities that have constituents, but lack any kind of structure and unity; they satisfy neither (1) nor (2).[5]

As it stands, (WSU) does not yet make room for comparisons among more or less unified composite entities which satisfy both sorts of structural constraints listed in (1) and (2). The following types of composite social (e.g., artifactual or institutional) entities, however, put some pressure on the account given by (WSU), since it is at least not prima facie obvious how they ought to be classified in relation to paradigmatic matter–form compounds which belong to natural kinds.

To illustrate, a screwdriver, for example, in order for it to be suitable for its intended purpose (viz., to loosen and tighten screws), should ideally consist of a handle (i.e., a part which allows the user to hold the screwdriver while tightening and loosening screws), a tip (i.e., a part which has the right shape to fit into the head of the type of screw on which the screwdriver is intended to be used), and a shaft (i.e., a part which connects the handle and the tip). The screwdriver's tip and shaft should be made of sufficiently hard material relative to the material composing the screws on which the screwdriver is intended to be used, so that the tip and the handle can maintain their physical integrity even after repeated use. The material of which the handle consists, as well as its shape, in turn are chosen in such a way as to fit comfortably into the user's hand and to maximize the user's ability to employ the device for its intended purpose. Screwdrivers, and artifacts more generally, thus appear to present us with examples of composite entities whose material parts must satisfy various type constraints and configuration constraints in order to compose a whole of the kind under consideration.[6]

Another interesting case to consider in this connection, is that of composite social entities belonging to *institutional* kinds, e.g., football teams. As long as we have in mind a sufficiently tolerant understanding of "configuration," it appears that instances of institutional kinds as well can be made to fit the structural constraints cited earlier. An American football team, for example, consists of a certain number of offensive and **(p.197)** defensive players who must be at least of the type, *human being*, in addition to whatever other requirements might be imposed on those who qualify for membership in a particular team. Due to their roles on the team (e.g., quarterback, line backer, etc.), these players occupy various positions within a configuration whenever they are engaged in carrying out a particular play. In this way, football teams, with their players as parts, seem to satisfy the structural constraints placed on wholes by (WSU), and therefore apparently gain admission into the category of highly unified matter–form compounds. In what follows, I focus on the case of artifacts; a detailed discussion of institutional entities would take us too far afield for present purposes.[7]

Such cases pose a challenge to (WSU) at least on the assumption that some distinction ought to be drawn between composite entities belonging to social kinds on the one hand, and paradigmatic cases of matter–form compounds coming from the natural realm (e.g., living organisms or chemical compounds) with respect to the extent to which they are recognized as unified. On the basis of what has been said so far, it is not yet obvious on what grounds composite entities belonging to social kinds could be assigned a different status from that granted to paradigmatic cases of highly unified structured natural wholes belonging to (WSU)'s top category.

7.3 Wholeness, Integrity, and Unity

The treatment of "Gestalt concepts" in Rescher and Oppenheim (1955) bears directly on the question of how the notions of wholeness, structure, and unity are interconnected. Rescher and Oppenheim are interested in proposing criteria which would, for example, disqualify a system consisting of three stones, selected at random, located in different continents, from counting as a genuine whole (Rescher and Oppenheim (1955), p. 90). As a starting point for their discussion, Rescher and Oppenheim offer three informal conditions as "intuitive requirements or conditions of adequacy which underlie our talk of *wholes*" (Rescher and Oppenheim (1955), p. 90; their emphasis throughout):

> (I) The whole must possess some *attribute* in virtue of its status as a whole—an attribute peculiar to it, and characteristic of it as a whole.
> **(p.198)** (II) The parts of the whole must stand in some special and characteristic *relation* of dependence with one another: they must satisfy some special condition in virtue of their status as parts of a whole.
> (III) The whole must possess some kind of *structure*, in virtue of which certain specifically structural characteristic pertain to it.

We may refer to systems which satisfy Rescher and Oppenheim's three criteria as *integrated wholes*, and to their components as parts that are *integrated* into these wholes.[8] Since Rescher and Oppenheim's third criterion is already contained in (WSU), I will in what follows simply take for granted that we should accept some version of (III), in particular one which interprets this criterion along the lines of the structural constraints in (1) and (2), as Rescher and

Oppenheim do. But the first and second criterion go beyond (WSU) and it is thus worth asking whether these criteria move us forward in our search for a meaningful and non-arbitrary way of ranking composite entities as more or less unified than some relevant comparison class. I will refer to the new proposal under consideration as (WIU), short for "Wholeness = Integration = Unity." (WIU) coincides with (WSU) with respect to (III), but supplements (WSU) with the addition of two new criteria, (I) and (II).

I begin with the question of how composite entities which meet the structural requirements set by (1) and (2) fare with respect to Rescher and Oppenheim's first criterion. Is there in general some attribute which these entities possess that is "peculiar" to them or "characteristic" of them as composite entities? When Rescher and Oppenheim speak of an attribute that is "peculiar" to and "characteristic" of a whole, one that it possesses "in virtue of its status as a whole," they have in mind the following (stated here in a simplified manner):

> *Rescher and Oppenheim's First Criterion*: An integrated whole must possess an *underivable* attribute, namely, an attribute which is (I.1) not also possessed by its parts; and (I.2) whose possession by the whole cannot be fully explained, relative to some theory, by appeal to the attributes possessed by its parts.[9]

(p.199) To illustrate, suppose a pile consisting of three stones weighs 3 kg, with each stone weighing 1 kg. Then, the pile of stones satisfies (I.1) by virtue of possessing the attribute of weighing 3 kg, since this attribute is possessed by the pile, but not by each stone individually, or by any two of the stones taken together. But the pile of stones does not thereby satisfy (I.2), since, given the right physical theory, the weight of the pile can be fully explained by appeal to the weight of the individual stones. Whether wholes ever really have attributes whose possession by the whole cannot be fully explained by reference to the attributes possessed by the parts is a controversial matter. Philosophers who are attracted to certain versions of physicalism or naturalism, for example, may wish to deny that any of the attributes possessed by a whole are ever truly underivable in the sense of (I.2). However, for the purposes of illustration, we may use as an example of an integrated whole which satisfies (I.1) and (I.2) a human being who possesses the attribute of being a moral agent: the parts of a human being individually, or smaller collections of these parts (arguably), do not themselves possess the attribute of being a moral agent and there is (arguably) no theory on the basis of which the possession of this attribute by the whole can be fully explained by appeal to the attributes possessed by the parts. The first criterion constitutes Rescher and Oppenheim's attempt at making more precise what might be meant by the saying, "The whole is more than the sum of its parts."[10]

Do composite social entities belonging to artifactual kinds, for example, satisfy (I.1) and (I.2)? We have at least the following two options in responding to this question. The first option assumes that we are serious about our ontological commitment to the entities in question, as numerically distinct from their constituents. According to this option, these entities belong to kinds to which we are already committed for independent reasons, and which therefore deserve separate entries in our ontological ledgers in addition to the entries we reserve for their constituents. In contrast, the second option assumes that, when pressed, we are inclined to opt for some sort of reductive analysis of the entities in question which somehow makes these entities disappear from our ontological ledgers and permits us to proceed with just the entries reserved for their apparent constituents. Choosing the second option leads to the result that these cases no longer constitute a potential challenge for the plausibility of (WSU). For if we feel drawn to the position that we need not really be committed to the existence of artifacts, for example, as entities in their own right numerically **(p. 200)** distinct from their apparent constituents, then (given their non-existence) we can also stop worrying about whether, or to what extent, artifacts are unified. In that case, the question of whether these apparent entities satisfy Rescher and Oppenheim's first criterion becomes a non-issue.[11]

Given the first option, Rescher and Oppenheim's criterion, at least on its own, cannot effect a meaningful and non-arbitrary ranking of composite entities which meet the structural constraints in (1) and (2) with respect to the extent to which they are unified, at least given the following assumption which I take to be plausible. Philosophers who are serious about their ontological commitment to the composite entities in question, in my view, should also want to ascribe to these entities some attributes which are possessed by them but not by their components and whose possession by these entities cannot be fully explained by appeal to the attributes possessed by their components. A case in point is modal attributes. It follows from the non-modal conception of essence to which I expressed my sympathies in earlier chapters that those who are serious about their commitment to the existence of screwdrivers, for example, as entities in their own right numerically distinct from the natural matter–form compounds which apparently compose them, would also be well advised to hold that screwdrivers possess certain modal attributes, e.g., being capable of tightening or loosening screws, which their individual material components, or smaller collections of them, do not possess, and whose possession by a screwdriver cannot be fully explained by appeal to the attributes possessed by their material components. That screwdrivers are the kinds of entities that are capable of tightening or loosening screws does not follow from the attributes (including the modal attributes) possessed by their material components (viz., the handle, tip, and shaft), or smaller collections of them, though whether a screwdriver *manifests* this capacity on any particular occasion is at least partly determined by how its material components conduct themselves in relation to one another.

Perhaps a screwdriver's possession of such attributes can be fully explained by reference to the acts and intentions of agents who are involved with their invention, design, production, or use. (In fact, given that screwdrivers have been invented and created by human beings to serve certain purposes, I take it that some such account of how screwdrivers come to possess the modal attributes they apparently do possess is highly plausible; we will consider several options for how such an account might be developed in Chapter 8.) But these agents (e.g., inventors, designers, producers, or users) are not themselves among the material components of a screwdriver on which, **(p.201)** through certain of their acts and intentions, they confer such modal attributes as being capable of tightening or loosening screws. We have after all assumed that if a screwdriver is a genuine structured whole, then its material components would be its handle, tip, and shaft. It would be unfortunate if our conception of artifacts led to the consequence that screwdrivers are mereologically composed of all those agents who have the power to contribute to the conferral of modal attributes on them. Instead, we should adopt the position that artifacts, assuming that we are serious about our ontological commitment to them, possess certain attributes whose possession cannot be fully explained in terms of the attributes possessed by their individual material components, or by smaller collections of them. If this point generalizes to other types of composite entities, on the assumption that we are to take our ontological commitment to these entities seriously as well, then we reach the conclusion that some underivable attribute can always be found by virtue of which these entities would satisfy Rescher and Oppenheim's first criterion. As a result, this criterion, at least on its own, cannot serve to rank composite entities which satisfy the structural constraints in (1) and (2) as more or less unified than some relevant comparison class.

The spotlight therefore is on the second criterion: we must now examine to what extent this criterion, together with our other apparatus, contributes to our ability to draw meaningful and non-arbitrary distinctions between composite entities which meet the structural constraints in (1) and (2) but differ with respect to their status as being more or less unified than some relevant comparison class. In their informal statement of the second criterion cited earlier, Rescher and Oppenheim formulate this criterion in two different ways: the first half of (II) requires the parts of a genuine whole to stand in some "special and characteristic relation of dependence" to one another, while the second half of (II) speaks of the parts of a whole as satisfying "some special condition in virtue of their status as parts of a whole." But there is an interesting and important difference between requiring the constituents of a composite entity to stand in "some special and characteristic relation of dependence" to one another and requiring these constituents to meet "some special condition" in virtue of being constituents of the composite entity in question: for not every such "special condition" dictates that the constituents of the composite entity stand in a dependence relation to one another. If the "special condition" requirement is construed too liberally, then (II) simply collapses into (I). For unless some restrictions are placed on how the “special condition” which figures in (II) is to be met by the constituents of a composite entity, whatever attribute the composite entity in question possesses in virtue of which it satisfies (I) can immediately be translated into a “special condition” met by the constituents which will allow these constituents to satisfy (II). For example, suppose that among the special attributes possessed by a screwdriver, in virtue of which it satisfies (I), is the attribute of being capable of tightening or loosening screws. Then, the tip, handle, and shaft, in virtue of the fact that they compose the screwdriver, also possess the corresponding attribute of being able to contribute to the screwdriver’s ability to tighten and loosen screws. For this reason, I regard Rescher and Oppenheim’s first formulation of (II) as **(p.202)** stronger, more specific, and ultimately more helpful for our present purpose than their second formulation.

In their more developed statement of (II), Rescher and Oppenheim in fact single out dependence relations as the relevant way in which the parts of an integrated whole must meet the “special condition” requirement. To state Rescher and Oppenheim’s second criterion, several technical notions are needed. “Definition 4” defines an attribute’s being “φ-dependent” on a class of attributes for the special case of quantitative attributes as follows:

> A quantitative attribute f of the part p_1 in a configuration of kind R of the n objects $p_1, p_2, \ldots, p_n$ is φ-dependent upon the class G of quantitative attributes of these objects p_i, if φ is a relationship such that in *every* configuration of kind R the f-value of the first member of this configuration is related by φ to the values which the quantitative attributes in G assume for the parts $p_1, p_2, \ldots, p_n$.
>
> (Rescher and Oppenheim, (1955) pp. 95–6)

A “configuration of kind R” is an ordered set of objects, $p_1, p_2, \ldots, p_n$, which stand in the relation R to each other, i.e., $R(p_1, p_2, \ldots, p_n)$ (p. 95). To assert a φ-dependence of the type defined in Definition 4 (often a functional relationship) is to assert that the connection between the value taken by p_1 with respect to f and the values taken by $p_1, p_2, \ldots, p_n$ with respect to G is *law-like*, i.e., generalizes across all configurations of kind R. Rescher and Oppenheim hold that the extension of Definition 4 to the non-quantitative case is readily available. “Definition 5” defines a “φ-dependence system” as follows:

> A configuration is a *φ-dependence system* relative to a set G of attributes if each part of the configuration has some G-attribute which is φ-dependent upon (some or all of) the G-attributes of (some or all of) the remaining parts.
>
> (Rescher and Oppenheim, (1955) p. 98)

With these definitions in place, Rescher and Oppenheim's second criterion can now be stated as follows:

> *Rescher and Oppenheim's Second Criterion*: The parts of an integrated whole must form a *φ-dependence system* relative to some class of attributes, *G*.

We shall say, in what follows, that the components of a system which satisfy the second criterion are unified under "lawful interdependence" with respect to some class of attributes, *G*, and relative to some set of laws or law-like connections.

To illustrate, consider the following system which, in Rescher and Oppenheim's view, satisfies the second criterion:

> … magnetic needles of equal strength are inserted in pieces of cork and floated, with all like poles upwards, in a basin of water. A strong magnet of unlike pole is placed in a fixed position overhead. The floating magnets arrange or rearrange themselves in a symmetric pattern of one or more concentric circles, depending on the number of magnets.
>
> (Rescher and Oppenheim, (1955) p. 95)

In this system, as Rescher and Oppenheim point out, the distance of one cork from the nearest adjacent corks is a function of the strengths and number of magnets involved **(p.203)** in the system. Thus, when the attributes in question include the distance of one cork from another as well as the number and strength of the magnets involved in the system, then the components of the floating magnet system are unified under the relation of lawful functional interdependence. The relationship in question is lawful, since the laws of physics dictate that similar systems behave in similar ways with respect to the functional determination of the distance of one magnet from the nearest adjacent magnet by the number and strength of magnets involved in the system.

Additional cases which are used by Rescher and Oppenheim to illustrate the workings of the second criterion include the following: the price of a commodity is dependent upon the distribution of supply and demand over the commodities in a financial system, according to the laws (or law-like connections) of classical economic theory; the temperature of a body part is dependent upon the temperature of the other body parts in a homeostatic systems, according to the laws (or law-like connections) of biology; the pressure of a gas is dependent upon its volume and temperature, according to the Van der Waals law of physical chemistry; the perceived color of an area is dependent upon the actual colors of the areas in the system, just as the perceived length of a line segment is dependent upon the actual lengths and angles of the line segments in the system, according to the laws (or law-like connections) invoked by Gestalt psychology; finally, the timing of the movement of one insect leg is dependent upon the number of legs and the timing of movement of the remaining legs of the insect, according to the laws (or law-like connections) of physiology.

Several important questions are currently still left open by the statement of the second criterion and the accompanying definitions cited earlier, among them questions concerning the nature and scope of the quantifiers implicit in (II). To avoid unnecessary clutter, the following disambiguations abstract away from the second criterion's appeal to the values taken by the components of a system with respect to some class of attributes. Let D be a division of a whole into parts; then at least the following readings of (II) are available, beginning with the strongest and ending with the weakest:[12]

> ($II_{Strong1}$) There is some dependence relation, R, such that every member of D bears R to every other member of D and no member of D bears R to anything that is not a member of D.
>
> ($II_{Strong2}$) There is some dependence relation, R, such that every member of D bears R to every other member of D.
>
> ($II_{Strong3}$) There is some dependence relation, R, such that every member of D bears R to some other member of D and no member of D bears R to anything that is not a member of D.
>
> **(p.204)** ($II_{Strong4}$) There is some dependence relation, R, such that every member of D bears R to some other member of D.
>
> (II_{Weak1}) Every member of D bears some dependence relation or other, R_1, …, R_n, to every other member of D and only to members of D.
>
> (II_{Weak2}) Every member of D bears some dependence relation or other, R_1, …, R_n, to every other member of D.
>
> (II_{Weak3}) Every member of D bears some dependence relation or other, R_1, …, R_n, to some other member of D and only to members of D.
>
> (II_{Weak4}) Every member of D bears some dependence relation or other, R_1, …, R_n, to some other member of D.[13]

The main differences between these readings of the second criterion are the following. The strong readings, ($II_{Strong1}$)–($II_{Strong4}$), require that there be a single dependence relation, R, which relates the members of D to one another. ($II_{Strong1}$) and ($II_{Strong3}$) differ from ($II_{Strong2}$) and ($II_{Strong4}$), in that ($II_{Strong1}$) and ($II_{Strong3}$) require that the single dependence relation, R, in question must also differentiate the members of D from surrounding entities, while ($II_{Strong2}$) and ($II_{Strong4}$) allow the members of D to bear the single dependence relation in question to surrounding entities as well. ($II_{Strong3}$) and ($II_{Strong4}$) weaken ($II_{Strong1}$) and ($II_{Strong2}$), in that ($II_{Strong3}$) and ($II_{Strong4}$) only require the members of D to bear the single dependence relation in question to some, but not all, members of D. The weak readings, (II_{Weak1})–(II_{Weak4}), allow there to be some variation in the dependence relations which members of D bear to other members of D. Otherwise, the weak readings exactly replicate the relationships described in the strong readings.[14,15]

(p.205) To illustrate, substituting functional dependence for "R," Rescher and Oppenheim's floating magnet system satisfies ($II_{Strong2}$), ($II_{Strong4}$), (II_{Weak2}), and (II_{Weak4}); but not ($II_{Strong1}$), ($II_{Strong3}$), (II_{Weak1}) or (II_{Weak3}). ($II_{Strong2}$) holds with respect to this system, since the distance between any two members of D is functionally determined by the strength and number of magnets involved in the system. Since ($II_{Strong2}$) entails ($II_{Strong4}$), (II_{Weak2}), and (II_{Weak4}), the floating magnet system also satisfies these conditions. But the system fails to satisfy ($II_{Strong1}$), ($II_{Strong3}$), (II_{Weak1}), or (II_{Weak3}), because the same physical forces which are at work in determining the pattern in which the corks and magnetic needles are arranged also hold between the members of this system and every other physical object in the universe (however weakly). As philosophers of science like to point out, no system, with the exception of the entire universe, is truly isolated and the same physical forces act on everything that is located in space-time. Thus, when the second criterion is read with functional dependence in mind and relativized to the contingent physical attributes of a system, the result is an overly weak interpretation of Rescher and Oppenheim's second criterion, according to which every physical system whatsoever counts as unified under lawful interdependence.[16] Our next step, therefore, is to inquire whether there are viable alternative interpretations of Rescher and Oppenheim's second criterion which can be used to draw meaningful distinctions between more or less unified systems.[17]

(p.206) 7.4 Ontological Dependence

It is tempting to turn to ontological dependence relations as plausible candidates for substitution into Rescher and Oppenheim's second criterion. As noted in Chapters 5 and 6, a plethora of relations have been defined in the literature under the heading of "ontological dependence." I restate here a representative sample of the definitions of ontological dependence discussed earlier:

(ND1) *Rigid Existential Necessary Dependence*:
x is rigidly existentially necessarily dependent on y $\equiv_{def}$ Necessarily x exists only if y exists.

(ND2) *Generic Existential Necessary Dependence*:
x is generically existentially necessarily dependent on Fs $\equiv_{def}$ Necessarily, x exists only if some Fs exist.

(ED3) *Essential Identity Dependence*:
x is essentially identity dependent on y $\equiv_{def}$ There is some function φ such that it is part of the essence of x that x = φ(y).

(ED4) *Constitutive Essential Dependence*:
x is constitutively essentially dependent on y $\equiv_{def}$ y is a constituent of x's essence (narrowly construed).

(ED5) *Constitutive Definitional Dependence*:
x is constitutively definitionally dependent on y $\equiv_{def}$ y is a constituent of a real definition of x.

In effect, (ND1)–(ED5) narrow down the class of "attributes" relative to which (II) is to be evaluated to just the existence, identity, essence, or real definition of the parts of a given whole. The parts of such a whole are thus unified under ontological interdependence, in the sense defined by (ND1)–(ED5), just in case these parts depend for the "value" they take with respect to their existence, identity, essence, or real definition on the "value" taken by the other parts of the same whole with respect to the same "attributes." Moreover, if it were in fact the case that the parts of an integrated whole are unified under ontological interdependence in any of the ways described earlier and this result furthermore generalizes across all composite entities which meet the first and third criteria, then the relationship in question would be lawful as well, as required by the second criterion.

(p.207) To see whether (ND1)–(ED5) yield a workable interpretation of Rescher and Oppenheim's second criterion, we must determine whether it is plausible to think of the parts of paradigmatic matter–form compounds as being unified under ontological interdependence, according to any of the definitions of ontological dependence just cited. For the sake of concreteness, consider a particular H_2O molecule whose material components are its two hydrogen atoms and its oxygen atom. (I will refer to these atoms as "H1," "H2," and "O," respectively.) Do H1, H2, and O ontologically depend on each other for their existence, identity, essence, or real definition in one or more of the ways defined by (ND1)–(ED5)? The answer unfortunately is negative, as can be illustrated by the following applications of (ND1)–(ED5) to two of the molecule's material components, viz., O and H1:

(A) O is not rigidly existentially necessarily dependent on H1, since it is not the case that necessarily O exists only if H1 exist.
(B) O is not generically existentially necessarily dependent on some hydrogen atoms, since it is not the case that necessarily O exists only if some hydrogen atoms exist.
(C) O is not essentially identity-dependent on H1, since it is not the case that there is some function φ such that it is part of the essence of O that O = φ(H1).
(D) O is not constitutively essentially dependent on H1, since it is not the case that H1 is a constituent of O's essence (narrowly construed).

(E) O is not constitutively definitionally dependent on H1, since it is not the case that H1 is a constituent of a real definition of O.

As (A)–(E) bring out, the material components of an H_2O molecule cannot be taken to be unified under ontological interdependence, according to any of the definitions of ontological dependence just listed. The existence of any particular oxygen atom does not require the existence of any particular hydrogen atom; nor does the existence of any particular oxygen atom require the existence of hydrogen atoms in general. Moreover, it is not plausible to think that a particular hydrogen atom (or hydrogen atoms in general) would figure in a criterion of identity for a particular oxygen atom; nor that a particular hydrogen atom (or hydrogen atoms in general) would figure in the essence or real definition of any particular oxygen atom (or of oxygen atoms in general). (A)–(E) suffice to establish that substituting an ontological dependence relation into Rescher and Oppenheim's second criterion does not provide a plausible interpretation of (II), even on the weakest reading of (II), viz., (II_{Weak4}), which requires only that every member of some division, D, of the whole in question bear some dependence relation or other to some other member of D. The particular case just considered constitutes a counterexample to this claim, since O does not bear any of the dependence relations cited above to either of the molecule's other two material components. (The choice of H1, relative to O, was arbitrary; hence, the same results generalize to H2 as well as to other cases.) We must therefore look elsewhere to find a viable alternative **(p.208)** interpretation of Rescher and Oppenheim's second criterion which accounts for the unity of integrated wholes.[18,19,20]

7.5 Interactional Dependence

Let's take stock. So far, we have established two negative conclusions, viz., that both of the attempts at providing a substantive account of unity considered earlier are unsuccessful. The first, put forward by Rescher and Oppenheim, was found to be too weak, since all physical systems are unified under lawful functional interdependence with **(p.209)** respect to their contingent physical attributes and relative to the laws of physics. The second proposal restricts the first by taking the parts of an integrated whole to be unified under lawful ontological interdependence with respect to their existence, identity, essence, or real definition and relative to the "laws of metaphysics." This account, in contrast, turned out to be overly strong, since even the parts of highly unified structured wholes do not in general ontologically depend on other parts of the same whole with respect to their existence, identity, essence, or real definition. What is needed, therefore, is an interpretation of Rescher and Oppenheim's second criterion that is intermediate in strength, i.e., one that is situated between those offered by the two rival accounts considered earlier. In what follows, I will attempt to develop such a proposal by focusing not on the contingent physical attributes or on the existence, identity, essence, or real definition of the parts of an integrated whole, but rather on their capacities to interact with one another in the particular mereological setting in which they find themselves as parts of an integrated whole.[21] I will refer to the members of a system in which the conditions specified below are met as unified under *lawful interactional interdependence*.

To motivate the account I offer in what follows, let's first consider an example: an eye that is part of a living organism which is capable of engaging in visual perception. While the eye is part of the living organism, it is able to contribute to the living organism's ability to see by manifesting certain of its capacities. But the eye cannot accomplish this alone. Rather, in order for the eye to make its contribution to the living organism's visual system, the eye's activities must be coordinated in the right sort of way with the activities carried out by other components of the organism's visual system (e.g., the brain). This sort of calibration between what the eye does and what the other components of the organism's visual system do requires that the eye is connected in the right sort of way to these other components of the organism's visual system. But mere spatiotemporal connection between, say, the eye and the brain is not enough to set the stage for the sort of interaction at issue. The eye's ability to interact with the brain in the right sort of way also requires that the eye and the brain (along with the other components of the organism's visual system) act and interact in certain specific and complex ways whose precise characterization is best left to scientists rather than metaphysicians. In this way, both the eye and the brain are integrated into the organism by playing a vital role in its visual system. If the eye were to be separated from the living organism, it would not thereby automatically cease to exist (contra Aristotle's Homonymy Principle). For it is plausible to think, given modern medicine, that under **(p.210)** the right circumstances this very eye could for example be preserved or transplanted into another living organism (or even potentially into an artificial system) where the very same eye can then take up its activities again, now as a contributor to the visual system of its new "host." But an eye which exists in a state separated from any such suitable surroundings is not able to manifest those of its capacities by means of which it can contribute to a living organism's ability to engage in visual perception. In turn, a living organism which is missing one of its eyes is not able to manifest its capacities for visual perception to the same extent as it would if the missing eye were present.

Generalizing from this example, we may informally characterize the interactional dependence relation required for the new interpretation of the second criterion as follows: an integrated whole derives its unity from the way in which its parts are able to interact with other parts of the same whole; the interplay between these activities carried out by the parts of an integral whole in turn allows the whole as well to manifest certain of its capacities, namely, those whose manifestation by the whole requires "team work" among its parts. I will refer to these capacities of the whole as "TWR-capacities" (short for "'team work' requiring capacities"). The relevant capacities of the parts are those by means of which the parts of an integrated whole contribute to the whole's ability to manifest its "team work" requiring capacities. I will refer to these capacities of the parts as their "contributing capacities" (short for "capacities by means of which a part contributes to the whole's manifestation of its TWR-capacities").

This informal characterization of the unity of integrated wholes highlights the way in which Rescher and Oppenheim's three criteria should be viewed as building on one another: (III) sets minimal structural requirements governing all wholes, whether they are integrated or not, while the unification of the parts of an integrated whole under (II) creates the right environment for certain successful instances of (I). In particular, the permissive reading of (II) witnessed earlier, according to which every physical system counts as unified under lawful functional interdependence, is now restricted by enforcing a connection between the whole's possession of certain underivable attributes, relevant to the satisfaction of (I), and the attributes of the parts that are at play in the satisfaction of (II). The former is achieved by way of the whole's manifestation of certain of its TWR-capacities, while the latter is due to the parts' manifestation of certain of their contributing capacities. To illustrate, a living organism which possesses the underivable modal attribute of being capable of engaging in visual perception (thereby satisfying (I)) is able to manifest this capacity by virtue of the complex interactions among certain of its parts (in compliance with (II)) which are configured in the right way and are of the right type to play a role in the organism's visual system (in accordance with (III)).

Our next task is to offer a more precise formulation of the second criterion, under the reading proposed, followed by an evaluation of how well this proposal performs with respect to our familiar test cases. Relative to the disambiguations offered previously, we must clarify, firstly, whether the interactional dependence relation needed for the proposed reinterpretation of the second criterion is *rigid* or *generic*; and, secondly, **(p.211)** where this relation fits with respect to the *weak* and *strong* readings distinguished earlier. To bring out, firstly, why the dependence relation in question need only be *generic* and not *rigid*, let's return once more to the specific case of visual perception considered earlier. To illustrate, if an eye, which is part of a living organism, were to stand in a *rigid* interactional dependence relation to the organism's brain, then the eye would require the *very* brain, with which it is, in fact, interacting, to be present and available for interaction, in order for the eye to be able to manifest those of its capacities by means of which it contributes to the organism's ability to engage in visual perception. In fact, however, the interactional dependence which obtains between the eye and the brain is only *generic*, insofar as the eye only requires *some* suitable brain *or other* (or some suitable analogue of a brain) with the right capacities to be present and available for interaction, in order for the eye to contribute in its respective ways to the organism's ability to engage in visual perception (together with the other components of the organism's visual system). We can extrapolate from this specific case that the manifestation of the relevant contributing capacities by the parts of an integrated whole in general requires only that *some* part *or other* of a certain kind with suitable contributing capacities be present and available for interaction, but not that any *particular* member of the kind in question be present and available for interaction within the same whole.

Secondly, by examining the specific case at hand, we can determine further which of the odd- or even-numbered strong or weak readings distinguished earlier provides the best overall fit for present purposes. Recall that the strong readings differ from the weak readings, in that the strong readings ($II_{Strong1}$)–($II_{Strong4}$), require that there be a single dependence relation, R, which relates the members of a division, D, to one another, while the weak readings (II_{Weak1})–(II_{Weak4}), allow there to be some variation in the dependence relations which members of D bear to other members of D. Moreover, the odd-numbered readings differ from the even-numbered readings in that the odd-numbered readings require that the dependence relation(s) at issue must also differentiate the members of D from surrounding entities, while the even-numbered readings allow that the members of D bear the dependence relation(s) at issue to surrounding entities as well. Finally, the third and fourth readings weaken the first and second readings, in that the third and fourth readings require only that the members of D bear the dependence relation(s) at issue to some, but not all, members of D, while the first and second readings require that the members of D bear the dependence relation(s) at issue to all members of D.

Since our reformulation of the second criterion makes use of a *single* dependence relation, viz., generic interactional dependence, we can exclude the weak readings and focus instead on the strong readings. Generic interactional dependence may be defined as follows:

(GID) *Generic Interactional Dependence:*
x, which belongs to kind K, generically interactionally depends on some member of kind K’ $\equiv_{def}$ (i) x, which belongs to kind K, has some capacities, **(p.212)** C_{K1}, …, C_{Kn}, and members of kind K’ have some capacities, $C_{K'1}$, …, $C_{K'm}$, and (ii) the manifestation of C_{K1}, …, C_{Kn} by x requires the manifestation of $C_{K'1}$, …, $C_{K'm}$ by some member of kind K’.

Among the strong readings, the first and second ($II_{Strong1}$)–($II_{Strong2}$), are overly strong in that they require *each* of the parts of an integrated whole to stand in a generic interactional dependence relation to *every* other part of the same whole. But an eye, for example, need not interact with the organism’s left toe, say, or even with *all* the other components of the organism’s visual system, in order for it to manifest those of its capacities by means of which it contributes to the organism’s ability to engage in visual perception. The third strong reading

($II_{Strong3}$), requires that the parts of an integrated whole interact in a certain *distinctive* way with other parts of the same whole in which they do not also interact with surrounding entities which are not integrated into the same whole as parts, to give rise to successful manifestations of the whole's TWR-capacities. The applicability of this reading to the case at hand, while perhaps ultimately defensible, requires some method of distinguishing, for example, between the eye's two-way interactions with the organism's brain on the one hand, and the eye's one-way interactions with features in the organism's environment (e.g., objects in the organism's visual field) on the other hand. For the time being, I will therefore make use only of the fourth strong reading ($II_{Strong4}$), reformulated here as ($II'_{StrongGID4}$), for the purposes of restating Rescher and Oppenheim's second criterion:

> ($II'_{StrongGID4}$) Every member of D is generically interactionally dependent upon some member of D.

With these clarifications in place, we may reformulate Rescher and Oppenheim's second criterion as follows, where (II') is to be read with ($II'_{StrongGID4}$) in mind and the relevant class of attributes possessed by the parts of an integrated whole is restricted here to their contributing capacities, i.e., to those capacities by means of which the parts of an integrated whole contribute to the whole's manifestation of its TWR-capacities:

> (II') *The Revised Second Criterion*: The parts, p_1, p_2, …, p_n, of an integrated whole are *lawfully generically interactionally interdependent* with respect to the manifestation of their contributing capacities, *C*, i.e., (II'.1) the value taken by any one part (e.g., p_1) with respect to the manifestation of some contributing capacity, *c*, is generically interactionally dependent upon the value taken by (some or all of) the remaining parts (viz., p_2, …, p_n) of the same whole with respect to the manifestation of (some or all of) their contributing capacities, *C*; and (II'.2) the relationship described in (II'.1) is governed by general laws or law-like connections.

When (II'1.) is read with ($II'_{StrongGID4}$) in mind, what holds for any *one* part of an integrated whole must hold for *every* part of the whole in question: that is, *every* part of an integrated whole must be generically interactionally dependent for the value it takes **(p.213)** with respect to the manifestation of some of its contributing capacities on the value taken by at least *some* of the parts of the same whole with respect to their manifestation of some of their contributing capacities. Moreover, given the *lawfulness* requirement in (II'.2), the relationship between the values taken by the parts of an integrated whole with respect to the manifestation of their contributing capacities must *generalize* to other similar systems which are governed by the same laws or law-like connections.

Returning now to our familiar test cases, we may ask to what extent composite social entities belonging to artifactual kinds satisfy the revised second criterion under the proposed reading. To what extent, for example, are the material components of a screwdriver unified under lawful generic interactional interdependence? To evaluate whether, and to what extent, (II') holds in this case, let's consider a particular TWR-capacity, C_S, e.g., the capacity of a Phillips screwdriver to tighten or loosen a Phillips screw, whose manifestation by the screwdriver requires the manifestation of certain contributing capacities by its material components, viz., the screwdriver's tip, shaft, and handle. The satisfaction of (II'.1) read with ($II'_{StrongGID4}$) in mind, requires that the value taken by *each* material component with respect to its capacity to contribute to the screwdriver's manifestation of C_S must generically interactionally depend on the value taken by *some* (though not necessarily all) of the other material components with respect to their manifestation of some capacity by means of which these other material components contribute in their respective ways to the screwdriver's ability to manifest C_S. Since the dependence relation in question is *generic*, and not *rigid*, every material component need only be related in this way to *some* material component of the screwdriver *or other*, but not necessarily to any *particular* material component. Further, the satisfaction of (II'.2) requires that the generic interactional interdependence among the screwdriver's material components generalizes to other similar systems governed by similar laws or law-like connections.

(II'.1) does appear to be satisfied in this case. To illustrate, consider the tip's contributing capacity, C_T, to fit into the head of a Phillips screw. While the tip is part of the screwdriver, it is able to contribute to the manifestation of C_S by the screwdriver by manifesting its contributing capacity, C_T. But the tip, by manifesting C_T, is only able to contribute to the manifestation of C_S by the screwdriver, if the tip's manifestation of C_T is properly calibrated with the manifestation of contributing capacities by the screwdriver's other material components, e.g., the shaft's ability to maintain its physical integrity even when a force within a certain range is applied to the screwdriver. It is, moreover, straightforward to see that the interactional dependencies which connect a screwdriver's material components are only *generic*, and not in general *rigid*: switching out one handle for another, for example, need not hinder, and may in fact improve, the tip's ability to contribute, by manifesting C_T, to the manifestation of C_S by the screwdriver. Finally, ($II'_{StrongGID4}$) allows that the screwdriver's material components must interact in particular ways not only with one another, but also with *surrounding* entities, e.g., a Phillips screw with the right sort of shape to be tightened or loosened by a Phillips screwdriver. In this respect, ($II'_{StrongGID4}$) contrasts with the third strong reading **(p.214)** ($II_{Strong3}$), which requires that the parts of an integrated whole bear the dependence relation in question only to other parts of the same integrated whole, but not also to other entities which are not themselves parts of the integrated whole in question.

An interesting contrast does emerge, however, between the case presently under discussion and the cases previously considered when we turn to the *lawfulness* requirement in (II'.2): for the domain of artifacts is not governed by laws or law-like connections in the same way, and to the same extent, as the domain of natural things. In the particular case at hand, for example, the hypothesis that each material component of a screwdriver *must* interact in particular ways with the screwdriver's other material components in the ways outlined here requires taking as fixed, among other things, the intentions of agents (e.g., inventors, designers, producers, or users) to engage in particular types of actions (viz., to tighten or loosen screws) contributed not by the screwdriver itself, or by its material components, but by factors external to the screwdriver itself and its material components. The assumption that an agent intends to put to use the artifact in question in order to engage in a certain type of action, in turn, gives rise to certain principles as to how a screwdriver's material components *ought* to interact with one another if the agent's practical goal is to be achieved. But such generalizations can be formulated only normatively and conditionally, on the assumption that the artifact in question functions as it ought to and is employed by a competent user in order to perform a particular type of action. These conditional normative principles by themselves do not dictate how, other things being equal, the components of a system *must* interact under certain conditions irrespective of the mental states of agents that are external to the system in question. Generalizing from the particular case at hand, then, composite social entities belonging to artifactual kinds do not appear to satisfy (II'.2) in the same way, or to the same extent, as paradigmatic matter–form compounds belonging to natural (e.g., physical, chemical, or biological) kinds. For the satisfaction of (II'.1) by the material components of an artifact in a particular case gives rise to a generic interdependence relationship which generalizes across similar systems only if the notion of lawfulness operative in (II'.2) is extended to include conditional normative principles governing the members of social kinds, in addition to the laws or law-like connections governing natural kinds.

7.6 Conclusion

In sum, we may conclude, then, that Rescher and Oppenheim's three criteria do yield a promising account of the unity of integrated wholes, provided that we interpret the second criterion in a certain way. What unifies the parts of an integrated whole is not that they functionally depend on each other for the values they take with respect to their contingent physical attributes (since all physical systems meet this condition). Nor can the unity of integrated wholes be said to be traced to the fact that their parts ontologically depend on each other for their existence, identity, essence, or real definition (since this requirement is not generally satisfied even by highly unified structured **(p.215)** wholes).

Instead, integrated wholes, so I have argued, derive their unity from the way in which their parts lawfully depend on each other for the manifestation of certain of their capacities, viz., those capacities by means of which the parts of an integrated whole contribute to the whole's ability to manifest those of its capacities which require "team work" among the parts.

An interesting consequence of the account of unity provided here is that it can also explain why highly unified wholes are capable of persisting through changes with respect to their parts and characteristics over time. For notice that we have only required that the parts of an integrated whole are generically, but not necessarily rigidly, interactionally dependent on other parts of the same whole. As long as an eye, for example, is able to interact with *some* brain *or other* (or some suitable analogue of a brain) with the right capacities, the eye can make its respective contribution to the organism's ability to engage in visual perception, assuming that the other components of the organism's visual system with which the eye must cooperate are also operating smoothly. The eye's ability, as well as the capacity of the organism as a whole, to engage in these carefully calibrated activities therefore does not turn on the numerical identity of the other components of the organism's visual system with which the eye is interacting, but only on there being some components or other of the right sort present and available for interaction. For this reason, switching out one suitable component for another within the organism's visual system does not affect the overall viability of its perceptual apparatus.

In the course of our discussion of unity in this chapter, some notable differences have emerged between paradigmatic matter–form compounds belonging to natural (e.g., physical, chemical, or biological) kinds and composite social entities, in particular artifacts. In the case of natural kinds, generic interactional interdependencies among the parts of an integrated whole generalize across similar systems which are governed by the same set of laws or law-like connections. In the case of artifacts, in contrast, we noted that the generic interactional interdependencies among the components of a system are at best governed by conditional normative principles which state how the components of these systems *ought* to interact, assuming that they are to contribute to the performance of certain actions in which agents external to the system in question intend to engage. We will continue our discussion of artifacts in Chapter 8 by considering the challenges posed by this particular domain for existing essentialist as well as anti-essentialist frameworks.

Notes:

([1]) This is what I gravitate toward in Koslicki (2008a), in the final pages of Chapter 7; however, for reasons which will become apparent shortly, I have since come to believe that my remarks concerning unity there were too quick.

([2]) In what follows, I will employ the following vocabulary in order to describe construction or composition operations in a neutral way, leaving open whether the operation in question satisfies (RCP^T) together with (1) and (2): “construction operation,” “composition operation,” “collection,” “constellation,” “plurality,” “system,” “assembly,” “constructed entity,” “composite entity,” “member,” “constituent,” “component,” “element,” “consists of,” “composes,” “is composed of,” and “forms” (used as a verb). Thus, we may speak, for example, of a *collection* or *plurality* of floating magnets (an example from Rescher and Oppenheim (1955) I will go on to discuss) as a *system*, a *constellation*, or an *assembly* of entities; of a non-empty set as a *collection*, or a *constructed*, or *composite entity*; of Socrates and Plato as *being members, constituents, components, elements* of, or as *composing* or *forming* the set containing Socrates and Plato; of the set in question as being *composed of* or *consisting of* Socrates and Plato; and of the operation of set-formation as a *construction* or *composition operation*. For the reasons just noted, however, it would be inappropriate to describe Socrates and Plato as *parts* of the set containing Socrates and Plato or of the set in question as a *whole* that is *mereologically* composed of Socrates and Plato, since the set-building operation fails to satisfy the structural requirements set by (1) and (2). While I am committed to the view that *mereological* composition for concrete particular objects is governed by (RCP^T) together with (1) and (2), I want to leave open that there may be other types of composition operations which apply in other cases and which do not satisfy these structural constraints. (See Fine (2010), however, for a more general understanding of mereological composition and parthood, according to which the members of a set can be said to be part of the set.)

([3]) According to the positive account of unity I will develop here, such entities as ice cubes or columns of smoke, for example, are classified as being roughly on a par with heaps of sand, piles of stones, or bundles of sticks with respect to the extent to which they are unified. I intend to use the term, “heap,” in a sufficiently broad manner to include all of these cases. (Thanks to Friederike Moltmann, pers. conv., for pressing me on this point.)

([4]) An interesting case to consider (suggested to me by Marko Malink) is that of a circle composed of curved segments. (For the sake of specificity, I construe the case at hand as involving a concrete token of the abstract geometrical type, *circle*, which is not created by an intentional agent for a particular purpose.) We are here apparently presented with a case in which both sorts of structural constraints are satisfied: a concrete instance of the geometrical type, *circle*, must be composed of parts of the type, *curved segment*, and these parts must be arranged in a circular way. However, the configuration constraints which must be satisfied in order for a collection of curved segments to compose a concrete token of the geometrical type, *circle*, are merely shape-related, as in the case of heaps. This example thus points to the possibility of drawing more fine-grained distinctions than those offered here among composite entities based on the idea that configurational constraints themselves can come in more or less demanding varieties. Although this direction strikes me as in principle a promising one to pursue further, I will in what follows focus on a different set of issues which require the introduction of additional apparatus not relevant to this particular case.

([5]) This raises the question: are there entities which satisfy the type constraints in (1), but not the configuration constraints in (2)? And, if so, how should these items be ranked with respect to their status as more or less unified than the other types of composite entities considered so far? We might think that certain kinds of collections, e.g., committees, fit this category. To illustrate, consider the US House Ways and Means Committee which is governed by very tight restrictions as to who can serve on it. Does the fact that the members of this committee satisfy certain type constraints warrant that the committee is designated as more unified than other types of composite entities whose components fail to satisfy analogous type constraints? If so, where should such a committee rank with respect to its unity compared to that exhibited by other types of composite entities, e.g., heaps? In principle, the ranking I have offered allows for the possibility of recognizing an additional category for entities satisfying (1), but not (2). Social kinds more generally, of which committees are a subspecies, turn out to be an interesting test case for my own favored approach to unity, and will concern us in more detail subsequently.

([6]) The reader may have noticed how natural it is to slip into *normative* language when describing the material components of which an artifact *ideally should* be composed and the configuration these material components *ideally should* exhibit if the artifact is to be used for its intended purpose. We will have occasion to return to this important characteristic of artifacts later in this chapter.

([7]) One might think that composite social entities, such as institutional entities or artifacts, can be immediately disqualified from the top (WSU)-category of highly unified structured wholes, on the grounds that the components of the system in these cases need not be continuously configured in a certain characteristic way at all times at which the system in question exists. For example, once a particular football game is over, the players who participated in the game can go their own separate ways without their teams therefore ceasing to exist. A similar characteristic seems to be prevalent among the members of many artifact kinds as well (e.g., bicycles, watches, trumpets, etc.), since they can apparently survive being disassembled and reassembled. In what follows, I will not place a heavy explanatory burden on the feature just cited, however, since it is possible for the constituents of a composite social entity to be permanently, and not just temporarily, configured in a certain way characteristic of the kind in question. A case in point might be, for example, social groups related by familial relations, such as being a parent of, being a child of, being a sibling of, etc., assuming that such systems in fact meet the structural constraints cited in (1) and (2).

([8]) For other relevant discussion, see also Fine (2010) and Simons (1987), especially Ch. 9, which examines Rescher and Oppenheim's proposal in detail and develops Simons' own notion of "integral whole." In what follows, I will employ the terms "integral" and "integrated," when used in connection with wholes, as synonyms. The notion of an integrated whole is also employed by Friederike Moltmann: Moltmann (1990, 1997a, 1997b, 1998, 2005). Moltmann's notion of integrated whole is much less restrictive than the one I will be developing here: according to her account, heaps of sand and football teams, for example, would count as integrated wholes. Schaffer (2013) employs the concepts of unity and integration in an argument in favor of priority monism, on the grounds that "to be one is to act as one" and only the entire cosmos, in his view, is a truly unified and integrated nomic system, governed by the fundamental laws.

([9]) The appeal to derivability in (I.2) may be read as leaving open the possibility of full explanations which are not statable in the form of logically valid inferences. Rescher and Oppenheim also note (see p. 93) that their definition of an underivable attribute is adapted from the definition of *emergence* given in Hempel and Oppenheim (1948). For a recent discussion of the different ways in which the concept of emergence is employed, see, for example, Wilson (2016).

([10]) If a certain entity possesses the attribute of being a moral agent, then, one might think, subtracting a few molecules from this entity still leaves us with something that is itself a moral agent. Does it follow from this that an entity which possesses the attribute of being a moral agent has proper parts which are themselves moral agents? This difficulty is an instance of what is known as the "Problem of the Many." Any view which allows that moral agents can have proper parts that are themselves (numerically distinct) moral agents faces the unwelcome result that apparently a staggering number of numerically distinct moral agents occupy highly overlapping regions of space-time, all of whom seem to care about the welfare of a single person. Since I take mereological composition to be restricted in the manner indicated earlier, I am not in general committed to the idea that large proper parts of any given whole of kind, K, themselves compose a further whole of kind, K. In what follows, I assume that we can bracket the Problem of the Many for the purposes of the present discussion.

([11]) We may, however, nevertheless wonder why, given the second option, mereological composition does not in fact take place in such a case, even though by all appearances the structural requirements in (1) and (2) are satisfied. The second option would answer this question by denying that the apparent kind with which we are presented by the case at hand is in fact a genuine kind to which we already take ourselves to be committed for independent reasons. Thus, on this view, a plurality of natural matter–form compounds arranged in such a way as to allow agents to engage in behavior we would describe as “tightening screws” or “loosening screws” fails to compose a further entity, viz., a screwdriver, because strictly speaking our ontology does not include artifacts as genuine kinds of entities in their own right, numerically distinct from the natural matter–form compounds which apparently compose them.

([12]) D is a division of a whole, w, just in case every member, x, of D is a part of w and for every part, x, of w there is a y that is a member of D, such that x overlaps y. A division whose members are disjoint is a partition (see Simons (1987), p. 327). I leave open whether the dependence relations in question are irreflexive.

([13]) Simons informally defines an “integral whole” as one which fulfils or at least approximates the following condition: “Every member of some division of the object stands in a certain relation to every other member, and no member bears this relation to anything other than members of the division” (Simons (1987), p. 327). Simons’ condition amounts to the strongest reading stated above, viz., ($II_{Strong1}$), with the restriction to dependence relations removed. Simons is well aware that, unless some such restriction is imposed on the relations under consideration, the criterion in question threatens to trivialize. He is in principle sympathetic to the idea that the parts of integral wholes are unified under an interdependence relation of some sort, an idea which also prominently figures in the work of Edmund Husserl and Roman Ingarden (see Husserl (1900–1); Ingarden (1925, 1960, 1965, 1974)). In Section 7.4, we will have occasion to examine some of the dependence relations Simons considers as candidate substitutions into a plausible and non-trivial criterion of integral wholes (see Simons (1987), especially Ch. 9; as well as Simons (1994) and Mulligan, Simons, and Smith (1984) for further relevant discussion).

([14]) Further weakenings of the second criterion are available, for example, by changing “every” to some appropriate weaker-than-universal quantifier (e.g., “most,” “many,” etc.); further strengthenings of the second criterion are available, for example, by requiring the dependence relation(s) in question to be mutual.

([15]) Rescher and Oppenheim also employ a distinction between “strong” and “weak” dependence, but they have in mind here the distinction between *deterministic* and *indeterministic* systems. Rescher and Oppenheim propose that the *degree* of dependence exhibited by a system can be defined based on the extent to which the value taken by a component of the system with respect to a G-attribute is either fully (i.e., non-probabilistically) or less than fully (i.e., probabilistically) determined by the values taken by the components of the system with respect to the G-attributes. Accordingly, indeterministic systems in general will exhibit a lower degree of lawful interdependence than deterministic systems, assuming that the characterization of the system includes all the relevant information necessary to capture the determination relation in question. Merely partial determination relations may also be due to *epistemic* factors, e.g., if our current state of knowledge concerning systems of the kind in question delivers only partial information concerning the relevant class of G-attributes.

([16]) Of course, not every such system will also qualify as an integrated whole, by the lights of Rescher and Oppenheim's account. For example, even though the floating magnet system satisfies the second criterion, in Rescher and Oppenheim's view (I.2) fails in this case, since the attributes possessed by the system as a whole (e.g., central symmetry) are *derivable*, i.e., they can be fully explained, relative to some theory, by appeal to the attributes possessed by the components of the system. In the remainder of this chapter, we will take up the important question of how the second criterion should be read in light of the restrictions placed on integrated wholes by the first criterion.

([17]) In addition to the disambiguations brought out by the weak and strong readings distinguished here, Rescher and Oppenheim's illustrations of the second criterion cited earlier raise several further questions which are not conclusively settled in the relevant section of Rescher and Oppenheim (1955) (see "Dependence Systems," pp. 95–9). According to Definition 4, the value taken by *one* component, p_1, of a given system with respect to a φ-dependent attribute, f, depends upon the values taken by *all* the components of the system (including p_1) with respect to the G-attributes (where it is assumed that f is not included in G). This definition is satisfied in the financial case, under the assumption that the price (f) of a commodity is not included among the G-attributes (supply and demand) and that the distribution of G-values (supply and demand) over *all* the commodities in the system (including p_1), i.e., p_1, p_2, …., p_n, determines the price (f) of any *one* commodity in the system (e.g., p_1). The relationship identified here is in effect a version of a mereological supervenience thesis, where the supervenience base includes the distribution of G-attributes over *all* the components in the system, p_1, p_2, …., p_n, and the supervenient feature is the value of the φ-dependent attribute, f, taken by any *one* component in the system, e.g., p_1. Definition 5, in contrast, states that a *φ-dependence system* is one in which the value taken with respect to some G-attribute, g, by *one* of the components, p_1, is dependent upon the value taken by some or all of the *remaining* components (excluding p_1), i.e., p_2, …., p_n, with respect to some or all of the G-attributes (possibly including g). This definition is satisfied, for example, in the case involving homeostatic systems, assuming that the temperature (g) of one body part, p_1, is dependent upon the temperature ($g = G$) of some or all of the remaining body parts, p_2, …., p_n; or in the case involving perceived and actual colors (G), assuming that the perceived color (g) of one area in the system, p_1, is dependent upon the actual colors of some or all of the remaining areas, p_2, …., p_n, in the system. Here, if the relationship identified in Definition 5 were to be stated in the form of a mereological supervenience thesis, the supervenience base would include the distribution of G-values (possibly including *g*) over p_2, …., p_n (excluding p_1), while the supervenient domain would consist of p_1's *g*-value. Unless otherwise noted, when I speak of the parts of an integrated whole as forming a system that is unified under lawful interdependence, I have in mind a *φ*-dependence system as defined in Definition 5.

([18]) The weak and strong readings formulated earlier, which disambiguate the second criterion, are directly applicable only when the dependence relation(s) at issue is (are) rigid, rather than generic, since rigid dependence relations take particular entities as relata. However, modified versions of the weak and strong readings may be formulated for generic dependence as well. Such readings omit the variations in the quantifiers as issue and instead focus only on the remaining two contrasts brought out above: firstly, whether the dependence relations are permitted to vary when considering different members of a single system (viz., as they are in the weak, but not the strong, readings); and secondly, whether the dependence relation or relations in question manage to differentiate the members of a single system from surrounding entities (viz., as required by the odd-numbered, but not the even-numbered, readings). I will return to the question below of how Rescher and Oppenheim's second criterion is best disambiguated when generic dependence relations are considered for substitution into (II).

([19]) Simons (1994) argues that the parts of integrated wholes are unified under ontological interdependence, in accordance with (ND1) and (ND2), a view that is also to be found in Husserl and Ingarden. To reach the result that the parts of an integrated whole are unified under rigid or generic existential necessary interdependence, Simons adopts the following (controversial) assumptions: concrete particular objects are bundles of tropes; these trope bundles can be divided into a "nucleus" (consisting of the object's essential tropes) and a "periphery" (consisting of the object's accidental tropes); the tropes in the nucleus are unified under rigid existential necessary interdependence; the tropes in the periphery are tied to the rest of the system through generic existential necessary interdependence. Simons' proposal in effect yields a version of the weakest reading of the second criterion, viz., (II_{Weak4}), according to which every member of D bears some dependence relation or other to some other member of D, with (ND1) and (ND2) specifying the range of dependence relations in question. Such a system does not satisfy the stronger readings of the second criterion, since (firstly) more than one dependence relation is required to capture the relationships in question, (secondly) the members of one system only bear the dependence relation(s) to some but not all other members of the system, and (thirdly) the members of this system also bear these dependence relations to surrounding entities. This is easy to see in the case of (ND2); but certain essentialist theses (e.g., the essentiality of origins) lead to the same result in the case of (ND1) as well. Whatever its other merits, Simons' proposal cannot be used to establish that an H_2O molecule's material components are unified under ontological interdependence: for each of these concrete particular objects is already an integrated whole, and Simons' proposal does not speak to the question of how these individual integrated wholes hang together and form a further integrated whole when they are assembled in the form of an H_2O molecule. In addition, I also take issue with some of the other trope-theoretic assumptions on which Simons' conception of the unity of integrated wholes relies.

([20]) It is possible to reach the desired outcome (that the material components of an H_2O molecule are unified under ontological interdependence in one of the ways indicated earlier) by taking on board Aristotle's so-called "Homonymy Principle," according to which the parts of a matter–form compound cannot survive being separated from the whole whose parts they are. As we saw in Chapter 4, in the context of our discussion of hylomorphic monism, a version of this position is endorsed by some contemporary hylomorphists (see, for example, Jaworski (2016b); Marmodoro (2013); Oderberg (2007); Toner (2006, 2008, 2010, 2011a, 2011b, 2011c, 2013)). According to my own hylomorphic conception of matter (see Chapter 2), however, the material parts of a hylomorphic compound can survive being separated from the whole of which they are part; thus, reading Rescher and Oppenheim's second criterion with an ontological dependence relation in mind is not an option for me, given my other commitments.

([21]) I intend my use of the term, "capacity," to be understood broadly in such a way as to encompass what is also sometimes referred to as "power," "potentiality," "potency," "propensity," "disposition," and the like. In the literature on dispositional essentialism in the philosophy of science, the ascription of a disposition to an object is often understood roughly as follows (see, for example, Bird (2007), p. 3): an object which has a dispositional property (e.g., being soluble in water) is such that it would give rise to some characteristic manifestation (e.g., being dissolved in water) in response to a certain kind of stimulus (e.g., being exposed to water). For present purposes, I do not mean to commit myself to any specific way of understanding the properties in question. For a recent account of potentiality, see Vetter (2015).