Synthesizing Activities and Interactions in the Concept of a Mechanism*

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Stuart Glennan, and the team of Peter Machamer, Lindley Darden, and Carl Craver have recently provided two accounts of the concept of a mechanism. The main difference between these two versions rests on how the behavior of the parts of the mechanism is conceptualized. Glennan considers mechanisms to be an interaction of parts, where the interaction between parts can be characterized by direct, invariant, change-relating generalizations. Machamer, Darden, and Craver criticize traditional conceptualizations of mechanisms which are based solely on parts interacting and introduce a new concept—activity. This essay is an attempt at carving out a relationship between these two philosophical interpretations of a mechanism. I will claim that, rather than being in conflict, Glennan's concept of interaction and Machamer, Darden, and Craver's notion of activity actually complement one another, each emphasizing a missing element of the other.

1. Introduction. The search for and discovery of mechanisms in the sciences abounds. Whether it is geology or molecular biology, biochemistry or cosmology, what is taken to be a causal explanation often consists of the description of a mechanism. The last two decades have seen a return to the philosophical analysis of the concept of a mechanism, but these efforts have predominantly evaluated the use of mechanical explanations in specific

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sciences.[1] For instance, Wesley Salmon (1984, 1989, and 1998) turns to the concept of a mechanism to explain processes in physics. William Bechtel and Robert Richardson (1993) evaluate the discovery of mechanisms in the neurosciences. And Kenneth Schaffner (1993) studies the application of mechanical explanations in biology and medicine.

Recently in this journal, Stuart Glennan and the team of Peter Machamer, Lindley Darden, and Carl Craver ("MDC" hereafter) have attempted to assess the concept of a mechanism more generally (Glennan 2002a and 2002b, MDC 2000; see also Glennan 1992 and 1996, Craver 2001, Darden 2002, Craver and Darden 2001, and Darden and Craver 2002). Glennan's, and MDC's versions of mechanism share many similarities; however, they also diverge at one important point: Glennan considers mechanisms to be an interaction of parts, where the interactions are occasions on which a change in a property of one part brings about a change in a property of another part (Glennan 2002b, S344). MDC criticize conceptualizations of mechanisms which are based on parts interacting, where the interaction is reduced to mere properties of the entities. For them, mechanisms are entities and activities producing regular changes. MDC are unabashed "dualists," requiring both entities and activities in a proper understanding of mechanism behavior (MDC 2000, 3).

Glennan claims that the current accounts of the concept of mechanism (MDC 2000 included, but also Darden 2002 and Thagard 1999) do have variations, but that "the basic view of the nature of mechanisms is similar to the one [he] propose[s] in Glennan 1996" (Glennan 2002a, 126, n.5). The dualists see this relationship in quite a different light. They not only take their turn to entities and activities to be different, they also take it to be more scientifically accurate and philosophically useful. The dualists identify a number of problems with the popular trend to conceptualize mechanisms in terms of parts interacting solely in terms of property changes. And in response, they argue for a turn to their concept of an activity. I will claim in this essay that, contra Glennan, the dualists' concept of an activity does offer a significant element of mechanism behavior that is importantly missing from his own. However, as opposed to the dualists, I will not go so far as to eliminate Glennan's notion of interaction and replace it with activity. Instead, I argue that both concepts emphasize important elements of a mechanism that are lacking in the contrasting concept.

1. I say "return" to contrast the more recent endeavors from the classic mechanical philosophy. There is a wealth of information on the virtues and vices of the 17th C. mechanical philosophy. For example, see Dijksterhuis 1961 (section 4), Glennan 1992 (chapter 2), Gillispie 1960 (chapter 3), Hall 1952, Westfall 1971, and Wilson 1999.

I begin by introducing the two accounts in Section 2 through the definitions they provide of mechanism and also use an example (chemiosmosis) to illustrate the different approaches to conceptualizing the behavior of parts in mechanisms. This is then followed in Section 3 with the comparison of activities and interactions. I evaluate here MDC's arguments for replacing Glennan's interactions with activities and claim that they have only shown the need to include elements of their concept of an activity along side of Glennan's interactions. Finally, Section 4 is devoted to determining what is missing from both the concepts activity and interaction as they now stand and how the opposing concept can be utilized to overcome that deficit.

2. Two Definitions of a Mechanism. The account of a mechanism provided by Glennan has evolved slightly over time (Glennan 1992, 1996, 2002a, and 2002b). Some important points have been refined and rephrased since Glennan 1996, but the basic motivation behind and presentation of his version remains intact. He defines a mechanism as follows:

> A mechanism underlying a behavior is a complex system which produces that behavior by of the interaction of a number of parts according to direct causal laws [sic]. (Glennan 1996, 52)

Glennan 1996 provides no direct definition for his concept of interaction at this point, but he does associate the term with ''direct, causal laws.'' The *direct* attempts to capture the fact that one part in the mechanism must be the immediate actor on the next part. If there are three cogs interacting in a machine: the first cog turns the second, the second turns the third; then the first cog is directly interacting with the second but *not* directly interacting with the third because it is not immediately inducing the change. The very general term ''causal'' is then in place simply to distinguish an actual cause from simple correlations (Glennan 1996, 55). Interestingly, at this point, Glennan offers his reader no discussion for the choice of the term ''laws'' to complete the definition. I return to this point momentarily.

Glennan 1996 presents the majority of his version of the concept of a mechanism; however, there are some important differences that emerge in Glennan 2002b, which are worth emphasizing. First and foremost, Glennan alters his definition of mechanism to:

> A mechanism for a behavior is a complex system that produces that behavior by the interaction of a number of parts, where the interactions between parts can be characterized by direct, invariant, change-relating generalizations. (Glennan 2002b, S344)

While interactions used to be governed by ''direct, causal laws,'' they are now characterized as ''direct, invariant, change-relating generalizations.'' Glennan now avoids using the term ''law'' to evade the many debates revolving around the philosophically loaded concept (Glennan 2002b, S345, n.1). ''Invariant, change-relating generalizations'' is borrowed directly from James Woodward (2000). Woodward's ambitious ''Explanation and Invariance in the Special Sciences'' attempts to provide an understanding of explanation in the special sciences which is not based upon laws (see Woodward 2001 for a more recent examination of this issue). The story is a familiar one: the traditional nomothetic conception of explanation takes successful explanations to rely on laws, conceiving of laws to be universal generalizations. Fields such as biology or sociology often provide scientists with apparently successful explanations without basing these explanations on the strict philosophical sense of laws, so how are these explanations to be evaluated and explained? Woodward's answer comes from the concept of invariance, which is based upon two other closely related concepts: intervention and a change-relating capability. An intervention is an idealized manipulation employed to determine whether changes in X are causally related to changes in another variable Y. The change-relating capability emerges in the change imposed on X and experienced by Y. The concept of invariance is then based upon this idealized sense of an intervention. A causal generalization identified between two variables is invariant if it would continue to hold as various other conditions change (Woodward 2000, 205). Glennan uses these concepts of invariance and a change-relating ability in his new definition of a mechanism. He defines an interaction as, ''an occasion on which a property change in one part brings about a property change in another part'' (Glennan 2002b, S344). The interaction, then, is the event whereby one part induces a property change on another part by virtue of its own change-relating capability. And the relationship between interacting parts is captured by the concept of invariance. In Woodward-speak, an interaction between two parts is invariant if it would continue to hold as other conditions change. This switch from ''causal laws'' to ''invariant, change-relating generalizations'' will be important to remember when taking the dualists' first criticism of the interaction-concept into consideration below.

Before turning to MDC, though, an example will help illustrate Glennan's notion of interaction as an induced property change. Take photosynthesis, the process of transforming light energy into chemical energy, which is then used to produce carbohydrates. I will focus on the first part of this process: the transformation of light energy into chemical energy, taking place in the thylakoids of chloroplast (see Figure 1). Here, photons are absorbed by pigment molecules in large complexes (referred to as photosystem II). The absorption of this light energy excites electrons

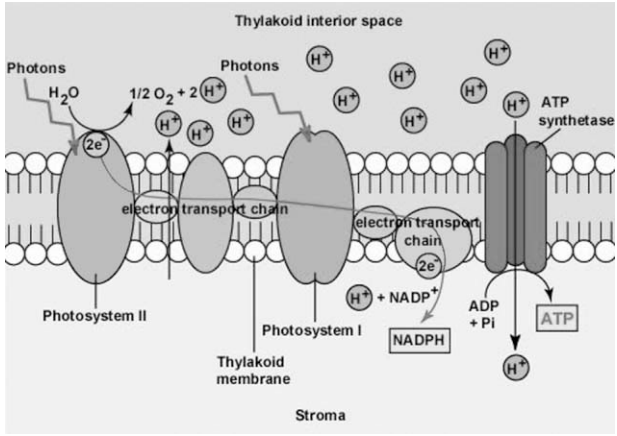

Figure 1. Electron transport and chemiosmosis during photosynthesis (Kaiser 2001). Reproduced by permission.

in photosystem II, which are then picked up by the electron transport chain. As the electrons are transported down the electron transport chain, released energy is used to pump hydrogen ions (H+) across the thylakoid membrane creating a positive charge within the thylakoid, and thereby producing a proton motive force. As these protons pass back across the thylakoid membrane by osmosis, chemical energy in the form of ATP is generated by ATP synthetase.[2]

There are many interactions in this simplified description of chemiosmosis, but I will focus on two: the interaction between photosystem II and the electrons it contains, and the interaction between the electron transport chain and the thylakoid itself. In the first interaction (see Figure 2) between photosystem II and the electrons it contains, as photosystem II absorbs light energy in the form of photons it undergoes a property change: an increased energy level. (I have represented this property change in the parentheses below; the energy (E1) at time T1 changes to the energy (E2) at the time T2.) This property change then brings about a property change in the electrons: a positional change. (I have represented this property change in the parentheses below; the position (P1) at time T1 changes to the position (P2) at time T2.) Thus, the property change in photosystem II brings about the property change in the electrons.

Now turning to the second interaction (see Figure 3) between the electron transport chain (E.T.C.), which received the electrons from the interaction above, and the thylakoid, as the electron transport chain absorbs

2. Peter Mitchell won the Nobel prize in 1978 for this chemiosmotic theory of ATP synthesis (Mitchell 1961).

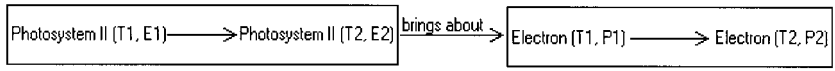

Figure 2. The interaction of photosystem II and the electrons it contains.

the electrons it undergoes a property change: an increase in energy. This property change then brings about a property change in the thylakoid: an increased positive charge (I have represented this property change in the parentheses below; the charge (C1) at time T1 changes to the charge (C2) at time T2). Thus, the property change in the electron transport chain brings about a property change in the hydrogen ions.

Figures 2 and 3 also help to reveal how Glennan's notion of interaction utilizes Woodward's concepts of invariance and a change-relating capability. An intervention can be made on the mechanism of chemiosmosis to establish the invariance of the relationship between the photosystem II complex and the electrons it contains or between the electron transport chain and the thylakoid. Likewise, a change-relating capability exists in both the photosystem II complex and the electron transport chain because the property changes they experience bring about the subsequent property changes in the electrons and the thylakoid.

MDC draw their case studies of mechanisms from scientific research in molecular biology and neurobiology and provide the following definition:

> Mechanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions. (MDC 2000, 3)

Activities, we are told, are the producers of change, while the entities are the things that engage in these activities. The dualists' entities and activities are "productive of regular changes." The regularity, for the dualists, comes from continuity between the various stages of the mechanism from beginning to end (MDC 2000, 3). By employing the notion of "regular changes," the dualists intentionally avoid the use of the term "law" in their definition. In fact, they criticize the use of the word found in Glennan 1996, claiming, "We find Glennan's reliance on the concept of a 'law' problematic because, in our examples, there are rarely 'direct causal laws' to characterize how activities operate" (MDC 2000, 4). The dualists' "Thinking About Mechanisms" was published prior to Glennan's (2002b)

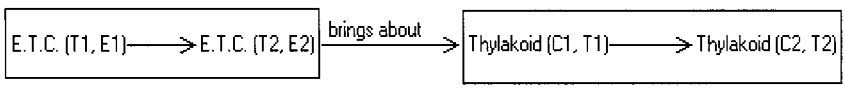

Figure 3. The interaction of the electron transport chain and the thylakoid.

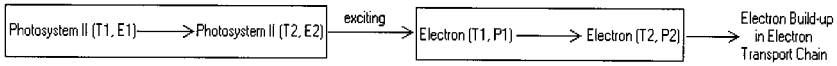

Figure 4. The exciting of electrons by photosystem II.

presentation of "Rethinking Mechanistic Explanations," so MDC's concern is valid. However, as we saw from Glennan's alterations of his definition in the most recent essay, this critique is no longer applicable. Glennan utilizes Woodward's notion of invariant, change-relating generalizations to avoid the very problem the dualists have identified. Whatever the advantages of activities over interactions, it is not simply that Glennan's interactions are reliant on the concept of a law while activities are not.

MDC provide much more than a definition of mechanism; they also show how this definition can be used to understand the scientific investigation of mechanisms. For example, they point out that mechanisms are generally idealized into start and finish conditions with intermediate activities in between. The start (or "set-up") conditions are taken as static time slices. The important entities and their properties such as structural properties and spatial relationships between entities, along with enabling conditions such as electrical charge are identified here. The finish (or "termination") conditions are also idealized into static time slices and considered to be the end of a particular stage of a mechanism, while the mechanism itself most often continues beyond this point (MDC 2000, 11). But mechanisms, argue the dualists, are more than these static beginning and end-points. The stages are dynamically connected via the intermediate activities. It is the ability of activities to *produce* the subsequent changes in the mechanism that keeps the process going. So if we are to understand mechanisms as active things, then the concept of activity is necessary to move beyond static descriptions of them (MDC 2000, 12).

Activities (and their power of production) can be best understood by comparing them with Glennan's notion of interaction. I will provide this comparison by revisiting the example of chemiosmosis discussed earlier. Taking the first case of photosystem II and electrons (see Figure 4), for the dualists, the activity is the exciting. MDC would also emphasize the way in which this activity is productive; it generates an electron build-up in the electron transport chain.

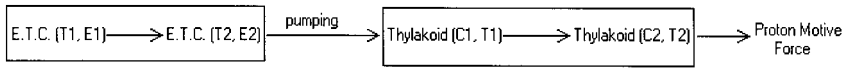

Figure 5. The pumping of thylakoid by the electron transport chain.

For the case of the electron transport chain and the thylakoid (see Figure 5), the activity would be the pumping of the hydrogen ions across the thylakoid membrane. And, once again, this activity is productive in an important way: it produces a proton motive force within the thylakoid, which then powers the construction of ATP.

3. Activities *versus* Interactions. An interaction, for Glennan, is an occasion on which a change in a property of one part brings about a change in a property of another part (Glennan 2002b, S344). This notion of transferring a change in property is borrowed from Wesley Salmon's concept of transmitting a mark or a conserved quantity, with the important switch to an invariant, change-relating capacity from Woodward (Salmon 1984, 1998, and Woodward 2000). Salmon's causal-mechanical account of explanation rests on the notion of a causal nexus as a network of interacting processes. Much of Salmon 1984 is an attempt at identifying what counts as valid causal processes and causal interactions. Salmon's analysis stems from problems he is addressing in physics. His version of a mechanism would be ideal for explaining the interaction between a pitcher and a baseball during the process of throwing a strike. The pitcher interacts with the baseball by transmitting momentum to the ball as it is released from his hand. A mechanism such as protein synthesis, though, would be more difficult to explain on Salmon's version since much of the process cannot be conceptualized in terms of conserved quantities. Glennan's alteration of what an interaction is in a mechanism is partly an attempt to move beyond the world of microphysics addressed by Salmon.

Interestingly, MDC also compare their activities to Salmon's talk of interactions, and also worry that Salmon's version is incapable of moving beyond the realm of fundamental physics (MDC 2000, 7). The dualists, in contrast to Glennan though, attempt to overcome this problem with the replacement of the concept of interaction with their concept of activity. The dualists take activities to be the *producers* of change, and complain that talk of interactions as occasions of induced property changes overlooks this productivity. The concept of productivity lies at the heart of the ontic justification for the dualists' turn to activities.[3] MDC (2000) provide no definition of their concept of productivity, but it has been called a type of cause which makes things up from other things.[4] There are many activities, but only some are productive; and it is this productive capa-

3. MDC (2000) argue for the ontic (§3), descriptive (§4), and epistemic (§7) adequacies of conceptualizing mechanisms in terms of activities. In this essay I am interested in how MDC and Glennan characterize the actual behavior of the parts of mechanisms differently, so I restrict my analysis to MDC's arguments for ontic adequacy.

4. This description of productivity was given by Machamer (personal communication). Thanks to both Darden and Machamer for discussing their concept of productivity with me.

bility, claim the dualists, which is so important in mechanisms because much of the phenomena found in mechanisms results from new entities with new activities being made up from old entities and old activities. I would argue that the dualists' requirement of productivity, rather than demanding an ontological switch from Glennan's interactions to activities, only reveals the need for interactions as Glennan conceives them alongside activities. This is because, while there are many activities, there are no productive activities that are not property-changing interactions.

One might challenge this claim by citing an example of an apparently *un*interactive activity, such as the conformation shift in cyclohexane from its "boat" form to its "chair" form. The cyclohexane molecule is actively performing an action, but the problem arises as to how this activity is productive. One could say that the boat form produced the chair form, and this is certainly true. But the cyclohexane molecule is not contributing anything to a mechanism at this point with the isolated, self-activated behavior. The cyclohexane molecule itself could be analyzed as a mechanism. However, now the change in conformation will be described in terms of interactions at the atomic level. In the case of cyclohexane, the shift from the boat form to the chair form results from hydrogen atoms repelling each other due to a common positive charge. The interaction between the hydrogen atoms forces the entire structure to take on the more stable chair form. We have now identified productivity in the cyclohexane molecule's behavior, but only after it was itself conceptualized as a mechanism and understood as a repelling interaction between hydrogen atoms.

Machamer (2002) has more recently argued that the attempt to define generally the concepts of activity and production is misguided. Instead, their abstract existence depends upon experiencing their existence as particulars. The idea here is that we should not waste time trying to define activity or production; it is as difficult as attempting to define "good" or "cause." In place of the definition, we identify instances of activity and production (Machamer 2002, 6). But if we are no better off at understanding production, then we are at understanding cause (in general or in particular), it is not at all clear that there ultimately is a payoff in turning to activities and their productivity. I will argue below that the situation is not so dire for activities; however, their salvation will come in the form of an odd ally: Glennan's interactions.

4. Activities *and* Interactions. A complete account of mechanisms requires elements of both interactions and activities, rather than a choice between the two. This interdependent relationship will be displayed best by first showing how each concept is incomplete without the other. After this initial step, the relationship itself will be examined. I will begin with a justification for including activities. I have argued above that the dualists'

claims did not justify the rejection of Glennan's interactions in conceptualizing mechanisms merely because these interactions lack productivity or are reliant on laws of nature. However, as I mentioned in Section 2, the dualists also offer another argument for turning to activities in the analysis of mechanisms and this is because mechanisms are *active* things. The dualists conclude this point to be yet another justification for replacing interactions reduced to property changes with activities.

The complete replacement of Glennan's interactions with activities based merely on the dynamic activity of mechanisms seems a bit extreme, but the dualists have raised an important point: dynamicity matters. The way that MDC argue for the need to capture this dynamicity with activities is by simply arguing that mechanisms are active things. They write, ''Mechanisms do things. They are active and so ought to be described in terms of the activities of their entities, not merely in terms of changes in their properties'' (MDC 2000, 5). But this argument seems to urge us to believe that mechanism behavior should be represented in the word that describes that behavior. This is a rather unconvincing argument. Why not just point out that the word ''interaction'' has the term ''action'' embedded within it too? I think the need for activities is made much clearer if we return to Glennan's own definition of an interaction: an occasion on which a change in a property of one part brings about a change in a property of another part. So much hangs on the two words ''brings about'' in this definition, for it is here that the actual property change takes place. And that change can take place in a variety of ways. When we are told that one property change brings about another property change, we must ask: How did the property change bring it about? What about the property change did the bringing about? What was the bringing about? It is essentially here that the dualists' notion of an activity comes to the rescue because it specifies how that change is produced or how it is brought about. *For the dualists, the activity is the dynamic process of bringing about.*

Epistemically, the dynamicity of change must be included in the conceptualization of a mechanism rather than reducing the mechanism to simple state transformations via property changes because leaving the definition at ''brings about'' unnecessarily black boxes an important part of the mechanism's behavior. Once that property change is induced and the state transformation is accounted for, the cause is known and so the philosopher's job is essentially finished. That is the danger if we let Glennan's concept of an interaction remain as it is, but this danger disappears with the inclusion of the dynamic aspect emphasized by the dualists' activities. MDC (2000) make essentially the same point but not in terms of avoiding the danger I mention. Instead, they argue that activities make phenomena intelligible (MDC 2000, §7). One way to think about MDC's emphasis on intelligibility is to contrast it with the black boxing

that emerges from limiting our understanding of interactions at "brings about." Activities make phenomena intelligible by opening this black box.

The second half of the relationship between interactions and activities rests on showing that activities cannot capture the behavior of mechanisms by themselves. Activities, claim the dualists, are the producers of change (MDC 2000, 3). But this very general definition of activity overlooks some important aspects of the process of change in mechanisms. For example, we must identify what is changed, and more importantly what makes the producer productive. There are many activities: binding, breaking, transporting, pushing, etc. The concept of an activity captures these various verbs in this basic form, but the minute one starts to examine in what sense these activities are to be productive in a mechanism, then some notion of Glennan's interaction as an occasion whereby a property change in one entity brings about a property change in another entity is required alongside of the concept of an activity. For example, returning to Figure 5 which depicts the activity of pumping producing a proton motive force, we can understand the fact that pumping can create a motive force, but this activity is only productive when it is embedded in a particular mechanism, and that embedding requires the specific property changes that are emphasized by Glennan's notion of interaction. This is why I claimed at the end of Section 3 that Glennan's interactions would be the dualists' ally. The concept of productivity, though abstract as Machamer (2002) suggests, becomes specified by reference to the particular property changes in the particular mechanism.

The fact that Glennan and MDC have come to different conclusions about how to accurately conceptualize mechanisms is not surprising. Glennan and the dualists approach the analysis of mechanism from two different philosophical programs. Glennan is focused primarily on the classical philosophical issues of causation and explanation; he seeks the elements of mechanical causation that lead to successful explanations. MDC, in contrast, are largely interested in the actual practice of science; they assess the various ways in which scientists investigate mechanisms. This is not to say that Glennan ignores scientific practice or that the dualists avoid discussions of causation; quite the contrary. I only want to point out here that they have approached the study of mechanisms from unique interests. These unique interests have lead to different emphases in their respective analyses. Glennan, interested in causation, has focused on where the causation lies in the behavior of a mechanism. State transformations via property changes provide that causation because the cause and effect is accounted for once the property change is complete. The dualists, focused on scientific practice, have emphasized the fact that scientists, in addition to studying entities, often also study dynamic processes: protein *synthesis,* neural *transmission,* chromosome *separation*.

I have tried to show above the impoverished view of mechanism that emerges if we attempt to take either interaction or activity alone. What remains is to explore the relationship between the two concepts. It should be clear by now that what is needed is a conceptualization of mechanisms that takes advantage of the emphases of both Glennan's interactions and MDC's activities. Glennan calls an interaction an occasion on which a change in a property of one part brings about a change in a property of another part. MDC have criticized Glennan, arguing for the switch to activities. But surely we do not need to make such a drastic move. The dualists' concept of an activity can be easily integrated into Glennan's definition of an interaction to solve their own critique. The resulting definition would be "an occasion on which a change in a property of one part dynamically produces a change in a property of another part." I have simply replaced the problematically vague "brings about" of Glennan's definition with the sense of dynamic production from the dualists. This dynamic production is generated in any number of different ways by what the dualists have been calling "activities."

Based on the different emphases made by Glennan's talk of interactions and MDC's discussion of activities, one way to conceptualize the relationship between the two concepts is synthetically. By this, I mean that, rather than having to pick which concept better describes the behavior of mechanisms, both can be used together in order to utilize the important emphases of each. What is needed, then, is a concept that accurately reflects the important elements of each theory, such as "interactivity."[5] This concept draws on the property changes that occur between entities of a mechanism emphasized in Glennan's analysis of mechanism. And it also takes advantage of the fact that the production of these property changes is a dynamic process, as the dualists have been claiming. Interactivity can be defined by the revised version of Glennan's definition of interaction discussed just above.

A synthesis of competing theories is always prone to criticism from both sides. For example, one might point out that the concept of interaction is much more familiar to the philosophical community, so the real project should be towards refining this concept and forgetting about activities all together. Or, perhaps the shift that comes from conceptualizing mechanisms with activities is significant enough to demand priority, and so the task should be one of renovating this new concept. I, however, claim that regarding the relationship between the two accounts in a synthetic manner is better for at least two reasons. First, both versions are growing in popularity where mechanisms are being discussed by philosophers. Unfortunately, few philosophers cite both versions and instead

5. Machamer first suggested the use of this term to characterize the union I am proposing.

choose one or the other to guide their interpretation of mechanisms.[6] In light of the fact that the concept of a mechanism plays such an important role in philosophy of science, it would be unfortunate if the communities interested in understanding mechanisms began to drift apart rather than come together simply because they took differing perspectives on the best way to conceptualize the behavior of the parts of a mechanism. Second, conceptualizing the relationship between the two approaches as a synthesis accurately reflects the fact that each approach has provided an important element to the ultimate understanding of a mechanism. If one of the approaches was clearly more developed, sophisticated, or comprehensive than the other, then it might make sense to simply amend the superior account with the inferior one. However, I do not view either of the versions as especially superior, and so the synthetic perspective seems the most justifiable.

Ultimately, of course, it is the recognition of the relationship between the two versions of a mechanism that is most important, and not whether or not one takes that relationship to be a synthesis. Either Glennan or MDC (and subsequent analyses of mechanisms) can utilize the relationship I have outlined above irregardless of whether or not they take their account to have been synthesized. I believe, however, that choosing one or the other would contribute to the tendency by philosophers to focus on *either* the Glennan or the MDC approach, rather than on both. And this would be to the great detriment of such developments in the literature on mechanisms in science.

5. Conclusion. Glennan and the dualists approach the analysis of mechanisms from unique interests, leading to different emphases in their understandings of how the parts of a mechanism behave. Glennan, starting from an interest in causation and explanation, has refined the traditional understanding of mechanisms by revising what it means to be an interaction in a mechanism. MDC, approaching the study of mechanisms from an interest especially based in scientific practice, have found the concept of interaction as induced property changes impoverished. They attempt to overcome this deficiency by utilizing their concept of activity. This essay was an attempt at clarifying the relationship between these two approaches. In contrast to Glennan, I argued that MDC's focus on the dynamic production of property changes is an important feature he

6. For utilizations of MDC's understanding of a mechanism, see Barendregt 2003, Boumans 2001, Brigandt 2002, Griesmaier 2003, Guala 2001, Morgan 2002, Silberstein 2001, and Thagard 2003. In contrast, the employment of Glennan's version can be found in Griesemer 2000, Mahoney 2001, and Rieber 2002. On rare occasions, both approaches are cited, as in the case of Newsome 2003 and Woodward 2002.

has overlooked. However, as opposed to MDC, I have not gone so far as to conclude that this oversight requires the replacement of Glennan's notion of interaction with activity. Instead, I have amended Glennan's definition of an interaction to take into consideration the dynamic productivity that the dualists rightly stress. Finally, I have claimed that it is best to think of the relationship I have suggested as a synthesis of the two approaches.

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