A TYPOLOGY OF EMERGENCE IN SOCIAL SYSTEMS AND SOCIOCYBERNETIC THEORY

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ABSTRACT

The concept of emergence, like that of complexity, is central to the development of sociocybernetics and social systems theory. The classical "whole is greater than the sum of its parts" model is a traditional model not only of emergence, but also of a social system, with individuals being the parts, and society (as derived through interaction among individuals) being the "emergent "whole". While the models of emergence as presented by Buckley, Luhmann, Miller, and others may differ in form and in their relation to complexity, they all recognize emergence as a "bottom-up" hierarchical concept. All of these models view emergence as aggregative and as essentially irreducible. However, emergence is a multidimensional concept, rather than being essentially unidimensional, as is usually assumed. The only way to adequately present and analyze all of the dimensions of emergence is through a typology. The purpose of this paper is to construct this typology. The typology will subsequently be used as a mechanism for recognizing and analyzing the various types of emergence that exist in contemporary social systems theory and sociocybernetics, with the aim of ultimately eliminating much of the confusion that now surrounds the concept of emergence.

INTRODUCTION

There has long been consensus that emergence is an important concept in social systems theory. But if this is true, how does one explain the varying descriptions of emergence in the literature? While there is consensus regarding emergence as an aggregative, hierarchical phenomenon that is resistant to reduction, different forms of emergent phenomena have been depicted by different theorists. For example, Buckley (1998, p. 33) emphasizes organizational emergence in which a discernible pattern of order arises during interaction, while Luhmann (1995, p. 22) notes that emergence can also occur from above (top down), and Miller (1978) emphasizes evolutionary emergence at eight hierarchical levels.

The fact is that while emergence is an indispensable concept in sociocybernetics, it is a multidimensional concept, rather than being essentially unidimensional and unitary as has generally been assumed. Perhaps the best way to adequately present and analyze all of the dimensions of emergence is to construct a typology. The purpose of this paper is to explore the various dimensions of emergence by formulating a typology of emergence. Lazarsfeld's (1937) processes of substruction and reduction will be used to construct the typology.

Substruction entails scrutiny of existing multidimensional type concepts in order to identify the multiple dimensions underlying them. These dimensions can then be expanded and combined to form a full typology. In the likely event that the full typology is so large as to prove unmanageable, the process of reduction can be used to further reduce it to a smaller number (but more than the original number) of theoretically relevant types of emergence. The goal of this typology is to provide a medium for recognizing and analyzing the various types of emergence that exist in contemporary social-systems theory and sociocybernetics, with the aim of ultimately eliminating much of the confusion that now surrounds the concept of emergence.

BUCKLEY'S ORGANIZATIONAL EMERGENCE

The concept of emergence, like that of complexity, is central to the development of socicybernetics and social systems theory. A set of elements or components need not be considered a system, even if the elements are similar in nature, and lie in close proximity. The collection of elements may simply be considered an eclectic congeries of elements that all happen to be close to each other, but are not interrelated, and thus have no visible system features. However, if these elements are seen to be arranged or interrelated in such a manner that "the whole is greater than the sum of its parts", then the totality is said to constitute a system, and to be of a higher degree of complexity (lower entropy) than a mere set of unrelated components.

As defined by Buckley (1998, p. 35), "The notion of system we are interested in may be described generally as a complex of elements or components directly or indirectly related in a network of interrelationships of various kinds, such that it constitutes a dynamic whole with *emergent properties*" (emphasis added). Buckley (1998, p. 36 says further that "When we say that 'the whole is more than the sum of its parts,' we are pointing to the fact of *organization* as the 'more than'…; and the 'sum of the parts' is taken to mean the unorganized aggregation" (emphasis in the original).

The classical "whole is greater than the sum of its parts" model is a traditional model not only of emergence, but also of a social system, with individuals being the "parts", and society (as derived through interaction among individuals) being the greater "whole". While this classical notion of emergence in social-systems theory has been attacked, Buckley (1998) ably defends it. Reductionist critics of the holistic emergence model say that it can be reduced to the concrete parts (individual actors) and the concrete interactions among them, thereby eliminating any "emergent" property. Their argument is that only the individuals and their interactions are "real", and are the only necessary elements, thus eliminating the need for a concept of emergence.

Buckley (1998, p. 184) responds by saying that "This ploy, however, gives away the argument and wipes out any significant differences with the notion of emergent system wholes, since a system or whole is made up of the parts *and the dynamic interactions among them*" (emphasis in the original). Buckley (1998, p. 183) says further that critics of social emergence have claimed incorrectly "that systems theory, in its concern for the whole and its emergent properties, ignores the components". Buckley (1998, p. 184) says that this is false, as "None of the founding theorists or important contributors have held such a view. The mistake perhaps derives from the emphasis often given to emergent properties and behaviors of the whole in the attempt to offset the strong reductionist tendencies in most of the sciences, which concentrate on parts".

Mihata (1997) describes social emergence in a similar way. However, rather than speaking of organization as Buckley does, Mihata (1997, p. 31) uses the terms "pattern" and "structure", in describing a particular form of emergence where "patterns or global-level structures arise from interactive local-level processes". Both Buckley's and Mihata's definitions of emergence contain three key elements—dynamic interaction, a two-level hierarchy, and bottom-up aggregation. While describing the range of systems, Buckley (1998, p. 35) says that system components may be simple and stable (static), and interrelations between them may be nonlinear. While this is a valid description of a simple system, most sociocybernetic systems which exhibit emergence are complex and nonlinear. For example, Mihata (1997, p. 32) states that "emergence is characterized by a nonlinear mode of organization".

Q-Analysis

The type of interaction described by Buckley and Mihata is the type most commonly described by verbal sociological theorists, including social systems and sociocybernetic theorists. This is interaction among a set of concrete objects, usually human individuals. Such interaction between concrete objects is called Q-interaction (see Bailey, 1990, 1994a). This action by individuals, or interaction between and among individuals, is initiated in specific social statuses, and is guided by norms within specific roles which are set in a specific context of class and culture. This leads to the visible patterns of social order or organization that were described by Buckley and Mihata.

In sociocybernetic terms such patterned behavior can be analyzed in terms of steering (see Luhmann, 1995, pp. 304-305), with self-steering being one of the most significant concepts in sociocybernetics (see Geyer and van der Zouwen, 1986). Role compliance and self-steering result in organized patterns of human action and social interaction that can be recognized as a primary form of emergence, thus serving as an illustrative case of "the whole" (e.g., a group) being "greater than the sum of its parts" (e. g., individual actors). Technically speaking, I can replicate or reproduce my actions on a daily basis by following the norms guiding my specific role. This can lead to organized or orderly behavior which is, strictly speaking, aggregative and cumulative. Such aggregative behavior does meet Buckley's minimal definition of organized emergence, but is linear (see Buckley, 1997, p. 35). More complex interaction among social actors is routinely nonlinear, and supercedes mere aggregation, as Buckley states.

Such nonlinear interaction occurs when one actor's behavior is contingent upon the behavior of others. For example, if person A asks person B to attend a party, this is aggregative action (two attendees instead of one). But if A asks B to attend a party, but B answers that he or she will only attend contingent upon whether person C does (or not) attend, then this is nonlinear behavior. Confusion arises in Q-analysis in verbal theory because theorists traditionally have used the term "interaction" to describe both linear and nonlinear action. Such conflation is a theoretical lapse that obfuscates important nuances in the analysis of emergence in social systems.

R-Analysis

This vital distinction between linear (aggregative) and nonlinear (statistically interactive) interaction can be clarified by analyzing R-analysis in sociology (Bailey, 1990, 1994a). The gap between verbal and statistical theory in sociology is unfortunately quite wide at times. One reason for this gap is that while verbal theorists use Q-analysis (between individuals) almost exclusively, quantitative sociologists such as statisticians and mathematical sociologists use R-analysis almost exclusively (with a few exceptions such as network analysis and blockmodeling). R-analysis does not examine relationships between objects such as individuals, but concentrates solely on relationships between variables (such as education and occupation). These variables are generally properties of individual actors, but must be analytically distinguished from the individuals themselves.

The phenomenon of emergence can also be explained by reference to a statistical paradigm which uses R-analysis. In the statistical sense, "the sum of its parts" which Buckley (1998, p. 36) calls "unorganized aggregation" is an additive model, and is shown in equation (1)

$$Y = a + b_1X_1 + b_2X_2 + \ldots b_nX_n \qquad (1)$$

However, interaction terms can be added to this additive (linear) model, as shown in equation (2)

$$Y = a + b_1X_1 + b_2X_2 + b_{1,2}X_1X_2 + \ldots b_{n-1,n}X_{n-1}X_n \qquad (2)$$

Or equation (3)

$$Y = a + b_1X_1 + b_2X_2 + b_3X^3 + \ldots b_nX^n \qquad (3)$$

While the whole is equal to the sum of its parts in equation (1), the whole is greater than the sum of its parts in both equations (2) and (3), because in addition to the additive effect, each of these equations also contains an extra statistical-interaction effect that emerges above and beyond the basic additive effect of equation (1). Notice that while equation (1) is linear, both equations (2) and (3) are nonlinear. Buckley (1998, p. 36) refers to the emergent nonlinear phenomena, as demonstrated in equations (2) and (3) as the "*organization* of the 'more than'" (emphasis in the original). In reality, the aggregation of system parts, as shown in equation (1), (and also in its Q-analysis counterpart, which we have discussed above, but have not presented in equation form), is not necessarily unorganized (this could be measured by correlation and regression coefficients) and not necessarily un-emergent. However, it is linear, and thus is a less complex arrangement of parts than is seen in the nonlinear representations of equations

(2) and (3) which are more clearly seen as emergent in their statistical-interaction components.

Pattern or organizational emergence can also be illustrated statistically with the notion of entropy. Shannon's H (Shannon and Weaver, 1949) is commonly used as a measure of statistical entropy in social-systems theory (see Bailey, 1990, 1994a), and is defined as

$$H = \_ \; p_i \ln p_i \qquad (4)$$

Where p_i is the probability of occurrence of a given category in a set of categories. Imagine that we have divided the population of a given society into five equal population categories (quintiles), with each category containing exactly one-fifth of the total population. If wealth were randomly distributed, so that each of the five population categories possessed exactly one-fifth of the total wealth of the society, than there would be no evidence of organization or order, or of any recognizable pattern, and thus no complexity. In this case entropy would be the maximum, and organization would be zero (minimum). In the polar-opposite case, one of the five population categories would contain all of the society's wealth. Here, entropy would be zero, and organization would be the maximum. Thus, entropy can be seen to vary inversely with organizational emergence, where emergence is defined in terms of a visible pattern of organized structure. A more direct measure of organization is provided by Rothstein (1958)

$$\text{Organization} = 1 - H_a/H_{max} \qquad (5)$$

where H_a is actual entropy and H_{max} is maximum entropy (see Bailey, 1990, p. 82).

Notice that in Buckley's organizational form, the existence of a hierarchy is implied, but largely remains latent. Although Mihata's specification of a "global" pattern hints at a more advanced hierarchy, Buckley speaks only of parts and wholes, with the system whole assuming the role of a higher level than the parts. Buckley's model implies that if we were confronted with a more developed hierarchy, emergence would proceed from the bottom up (aggregatively), with the higher levels becoming progressively more advanced, more complex, and more emergent as we proceeded up the hierarchy.

MILLER'S HIERARCHICAL EMERGENCE

Miller (1978, Miller and Miller, 1992) analyzes emergence in the context of eight hierarchical levels: the cell, organ, organism, group, organization, community, society, and supranational system. In addition to pattern emergence, as previously discussed, Mihata (1997, p. 31) recognizes a second type of emergence that he calls "emergent evolution" where new properties emerge which have never before existed. Mihata (1997, p. 32) says, "Thus, emergence concerns not only relationships among parts of a 'whole' but also the possibility of new levels emerging over 'evolutionary' time and the nonlinear relationships between qualities or properties at different levels". Miller's hierarchical analysis exhibits both types of emergence, pattern emergence and new variable (or new property) emergence. In the former case, a move to a higher level of the hierarchy will reveal additional complexity and a higher degree of order, but no new properties. In the latter case, a move to a higher hierarchical level will reveal new properties. I have previously referred to these two types of emergence in Miller's theory as transformational emergence (where old variables are transformed at higher levels of the hierarchy, but no new variables emerge), and new variable emergence (see Bailey, 1994a).

According to Miller's (1978, Miller and Miller, 1992) theory, each of the eight hierarchical levels of living systems depend upon the functioning of the same 20 "critical subsystems". These subsystems are specialized as to whether they process matter-energy or information. Only two of the 20 are said to process both matter –energy and information (the boundary and the reproducer). Eight of the remaining subsystems process only matter-energy. These are: the ingestor, distributor, converter, producer, matter-energy storage system, extruder, supporter, and motor. The remaining 10 subsystems process information only. These are the input transducer, internal transducer, channel and net, decoder, associator, timer, memory, decider, encoder, and output tranducer.

New Variable Emergence

Miller's eight hierarchical levels are said to be "nested", meaning that lower levels fit within higher levels. More importantly, these lower levels generally serve as subsystems of the next higher level (and sometimes of even higher levels). Thus, a given level is not mutually exclusive or autonomous in its own right, but contains lower-level systems as its subsystems, and itself serves as a subsystem for the system immediately above it in the hierarchy. Miller sees his eight levels as an evolutionary emergent hierarchy. For example, organisms (the third level from the bottom) evolve into groups (the fourth level), which in turn evolve into organizations, which evolve into communities, and so forth. While never saying that the levels are arbitrary, Miller (1978, p. 1030) does admit that there may be additional levels that could be included in addition to these eight. In fact, he originally declined to admit the community as a level (Miller, 1978, p. 1030), but added it later (Miller and Miller, 1992).

Miller (1978, p. 1037) claims emphatically that his theory is not reductionist, saying that "The theory described in this book is not reductionist as defined above. It holds that systems at higher levels have emergent characteristics". Unfortunately, the examples he provides to prove his case deal with nonliving systems, not with the social systems that are the chief concern in social systems theory and sociocybernetics. He notes (Miller, 1978, p. 1037) that while a radio can provide audio signals, a television has a further emergent property (video). This is an example of new variable emergence, as the television set has an addition property (video) that the radio does not have.

However, he does support his claim with living systems as well, staging that the organizational level is distinct from the group level by stating that organizations possess a new property--an internal hierarchy or command structure (echelon) that is lacking in groups. Thus, one cannot reduce the organization level to the group level because the latter lacks echelons. In this case, the hierarchy is emergent, and is not reducible. Another example of new variable emergence occurs when moving from the organism level to the group level. An organism cannot be a group because it is singular, and cannot have interaction with another organism at this level, as is possible in a group. Thus, social interaction is a new variable that is lacking at the individual level but arises at the group level. For further discussion of new variable emergence see Bailey (2005a, 2005b).

Transformational Emergence

But even without new-variable emergence, Miller (1978, p. 1044) makes the case for emerging higher levels based on increasing size and complexity at the higher levels, stating that "There are step-function changes in the magnitudes of variables like median diameter and median duration of existence from one level to another." In this form of emergence no new variable emerges, but the old variable are transformed in terms of size and age.

Miller (1978) provides numerous examples of transformational emergence. One example is the producer, which transforms from a cook at the organization level to a food-processing company at the society level (Miller, 1978, p. 607 and p. 767). In both cases the producer prepares food. There is no new property or variable emerging from the organization level to the society level. The only emergence is transformational, where the cook on the organizational level is transferred in size and complexity to the food processing company on the society level. For additional examples of transformational emergence see Bailey (2005a, 2005b).

Vulnerability to Charges of Reductionism

The fact that Miller claims the existence of the identical 20 subsystems at all eight levels of his hierarchy makes Living Systems Theory (LST) especially vulnerable to charges of reductionism (see Miller, 1978, pp. 1036-1037). For example, reductionist critics can ask, if both the organizational and the group level contain the identical 20 subsystems, then why should we even recognize these as two distinct hierarchical levels? That is, if the group level was said to possess only 16 subsystems, while the organizational level had 20, then one could see the validity of calling these two distinct levels, and in claiming that the organizational level was an emergent level of greater complexity than the group level. But if indeed both levels have the same 20 subsystems, as Miller contends, why not collapse these two levels, either by recognizing the organization as a large group, or by recognizing the group as a small organization?

Unlike the autonomous levels described by Luhmann (1995), Miller's levels are all characterized by "one-level drop back" (see Bailey, 2005a), meaning that systems at a given level comprise the subsystems for the next higher level, and thus can also be considered components of systems occurring at that higher level. Thus, unlike Luhmann's model, each higher level of Miller's hierarchy is higher in complexity, and is also said to constitute a higher level of emergence. However, in Miller's schema, the same 20 critical subsystems occur at all eight levels, apparently making his formulation vulnerable to charges of reductionism. Some of the emergent properties at a given hierarchical level in Miller's model are new at that level (such as internal echelons at the organizational level), while other properties at a given level may also exist at lower levels (in a less complex form), and so can be considered "emergent" only in terms of form and degree of complexity.

Miller's emergence claim is further weakened by LST's apparent vulnerability to charges of reductionism in three areas—the somewhat arbitrary nature of the levels, the lack of a subsystem for the group and organization level, and the practice of drop-back and downward dispersal. As for the first cases, Miller and Miller's (1992) description of the eight levels is inconsistent because Miller (1978) had already written his theory in terms of seven levels, omitting the community level. Because of the one-level drop-back (the third case), this means that the subsystems for the society level were *not* communities, but were organizations. If the 1978 volume were to be rewritten, one would have to replace the word "organization" with the word "community" in every discussion of the 20 subsystems for the society. For example, Miller (1978, p. 767) gives as an example of the associator subsystem of the society the organization (such as a school) and *not* the community, thus indicating that the community level is unnecessary, and could be reduced to the organization level.

Also smacking of reductionism is Miller's (1978, p. 766) use of the concept of "downward dispersal" where a subsystem at one level (for example, the society), may not be at the level of the organization, but may be further "dispersed downward", all the way to the organism (individual) level. Miller (1978, p. 766) says that the ingestor for the society is "an organization which imports matter-energy", such as an airline or trucking company, but adding further that the ingestor for the society "may be downwardly dispersed to group or individual person". Notice that if the community level is included in the hierarchy between the society level and the organization level, then using the organization as a subsystem of the society constitutes a two-level drop back, while the group is a three-level drop back, and the individual is a four-level drop back. If the four-level reduction were to be applied across the board for all 20 critical subsystems when analyzing the society, then Miller's hierarchy would be reduced to the familiar individual and society dichotomy that is familiar in social-systems theory.

Another factor that makes LST vulnerable to charges of reductionism is the fact that some of the subsystems either do not exist empirically, or have not yet been discovered empirically. The original set of seven levels and 19 subsystems forms a matrix of 133 cells (Miller, 1978, pp. 1028-1029). Unfortunately, the associator is listed as unknown at the cell, organ, and organization levels. On the face of it, this might indicate that not all of the levels or subsystems are needed.

Alternatively, one might argue that the missing cells support Miller's claim of evolutionary emergence, because the memory and associator do exist at the higher levels of the hierarchy, but are missing at the lower levels, and only emerge at higher levels of the hierarchy. Another factor in LST that mitigates against reductionism is the fact that Miller lists 173 hypotheses or propositions regarding two or more hierarchical levels (Miller, 1978, p. 1031). If one writes a hypothesis comparing the rate of information processing simultaneously for the individual, group, and societal level, it would seem difficult if not impossible to reduce or collapse these levels if different processing speed were found across levels.

LUHMANN'S THEORY OF AUTOPOIESIS AND SOCIOCYBERNETICS

To this point we have discussed emergence as a phenomenon that is created through aggregation from below. But as Luhmann (1995) points out, we need not always view complexity as being formed from "below" by producing emergent phenomena from the combination of parts. Luhmann (1995, p. 22) says that the unity of an element can also be formed by constitution from above. This means that elements of a system at a given level are to be considered elements only for this level, and cannot necessarily be seen as elements of subsystems of higher levels. This model has a number of consequences. As Luhmann (1995, pp. 22-23 notes): "One of the most important consequences is that systems of a higher (emergent) order can possess less complexity than systems of a lower order because they determine the unity and number of the elements that compose them; thus in their own complexity they are independent of their material substratum…Thus emergence is not simply an accumulation of complexity, but rather an interruption and new beginning in the constitution of complexity." Here Luhmann is raising important questions about dependence and autonomy among levels (see Poli, 2001). These are important issues for students of emergence.

Luhmann (1995, pp. 304-305) notes the importance of emergence to the notion of steering. Self-steering is one of the most important concepts in sociocybernetics (see Geyer and van der Zouwen, 1986). Luhmann (1995, pp. 304-305) says, "But the level of the expectation of expectations offers additional means for integrating expectations as a means of steering behavior. The level of reflection forms an *emergent* level of order with its own forms of sensibility" (emphasis added). Luhmann (1995, p. 448) later again notes the importance of social-system emergence, saying that "Typical features of system formation emerge from the requirement of basal self-reference."

Luhmann (1995, p. 22) introduced the possibility of divisive emergence by alluding to constitution "from above". While he did not explicitly refer to such top-down constitution as "emergence", there is no reason why the genesis of an element should not be viewed as emergent whether the new element is produced through aggregation as is traditionally recognized, or through division and specialization of a previously undifferentiated structure. I am now referring specifically to Luhmann's (1989) notion of the differentiation of function systems. If a function system such as education or law develops (divides) over time from a previously undifferentiated whole, who is to say that this is less "emergent" than the aggregative emergence that has been traditionally recognized?

TOWARDS A TYPOLOGY OF EMERGENCE

The goal of this paper is not to force a unitary view of systems emergence, but merely to document the variety of approaches to emergence that exist, and to clarify the relations among them. This can be best be done through Lazarsfeld's (1937) complementary processes of typological substruction and reduction. Substruction identifies the various dimensions underlying a multidimensional type concept, and uses them to construct the full typology. The problem is that the full typology can often be unmanageable. For example, if one finds 12 underlying dimensions, combining these (even in their dichotomous form) will yield a typology containing 2^{12} or 4096 cells. Then, the three types of reduction (arbitrary numerical, pragmatic, and functional) can be subsequently used to reduce the full typology to a more manageable number.

Substruction

We have identified several important types of emergence including Buckley's organizational emergence, Miller's "step-function change" (transformational) emergence, Mihata's new evolutionary emergence, and Luhmann's top-down, autonomous level (non-nested) emergence. Obviously these four prominent types represent only four cells from a multi-cell typology that can be formed their underlying dimensions. Substruction begins by listing the types of emergence discussed thus far in this paper. The following

12 underlying dimensions of the various types of emergence have been identified and noted.

1. Linear/nonlinear
2. Static/dynamic
3. Non-evolutionary/evolutionary
4. Non-ordered/ordered
5. Simple/complex
6. Two-level-hierarchical/multilevel-hierarchical
7. Transformational/new variable
8. Small/large
9. New/old
10. Bottom-up/top-down
11. Aggregative/divisive
12. Non-nested (autonomous)/nested (non-autonomous)

Reduction

The usual procedure would be to form the 12-dimensional typology through substruction, then to use various forms of reduction to reduce the number of types below 4096. However, given the large number of cells in the full typology, and the fact that the full 12-dimensional typology cannot be presented on a two-dimensional sheet of paper, it behooves us to reduce the number of dimensions before proceeding to the reduction of types. One way to accomplish this is to search for multicollinearity among the various dimensions. When we find two or more dimensions that may be highly correlated, we can theoretically choose one to represent the entire subset of related variables, and omit the other dimensions from the typology.

The linear/nonlinear dimension (dimension 1) has been identified as salient, and so will be included in the typology (even though perhaps the vast majority of emergent types are deemed nonlinear, see Mihata, 1997). The time dimension is represented in dimensions 2 and 3 (static/dynamic, and evolutionary/non-evolutionary). Since these are correlated, I will choose static/dynamic, and omit the evolutionary terminology (although it can be used in future analyses). Dimensions 4 and 5 are correlated, as both represent the degree of organization. I will choose the terminology of dimension 5 (simple/complex) and omit the terminology of order. Three alternate terms are organization (used by Buckley, 1998) and pattern and structure (used by Mihata, 1997). A noncomplex (simple) system cannot exhibit order, pattern, or structure. Future research could even fashion a typology solely from the dimensions of complexity, order, organization, pattern, and structure, but this is too nuanced for the present preliminary effort, and so will be eschewed here.

Dimension 6 (hierarchy) is central to the typology, and will be included. This dimension requires further discussion. Buckley's (1998, p.31) basic model of emergence identifies only two levels, the level of the elements, and the level of the "dynamic whole". These two minimal hierarchical levels of emergence can be alternatively described as part/whole, component/system, individual/group, individual/society, local-level/global-level (Mihata, 1997, p. 31), microscopic/macroscopic (Minati and Pessa, 202, p. ix), and so forth. This basic two-level model of emergence stands in contrast to multi-level emergence models such as Miller's (Miller and Miller, 1992) eight-level hierarchy. Thus, dimension 6 is represented in our typology as a two-level-hierarchy versus a multilevel-hierarchy (three or more levels).

Dimensions 7 (new variable/transformational), 8 (size), and 9 (age) are correlated, as the latter two represent forms of transformational emergence used by Miller (1978). Since using all three would be redundant, only dimension 9 (new/old) is included in the typology. Dimensions 10 (bottom-up/top-down) and 11 (aggregative/divisive) are highly correlated, so the wording of number 10 will be retained since it is more familiar and recognizable. The final dimension (number 12, non-nested/nested) is important and will be included in the typology. In all, seven of the 12 dimensions are included in penultimate typology. These are the dimensions of linearity, complexity, static/dynamic, hierarchy, age, nested/non-nested, and bottom-up/top-down.

Unfortunately, even after omitting five dimensions from our list of 12, we still are faced with a typology of 128 cells. While this typology can be presented in a future paper, time and space considerations require us to reduce the typology still further. Since the vast majority of the cases of emergence encountered in sociocybernetics and social systems theory are complex (dimension 5), nonlinear (dimension 1) and dynamic (dimension 2) we can omit these three dimensions, thus reducing the size of the typology from 128 cells (with seven dimensions) to only 16 (with four dimensions).

One chief goal of this typology is ensure that all empirical cases of emergence can be properly classified by constructing a typology that is mutually exclusive and exhaustive (see Bailey, 1994b). While the 16-cell typology is obviously less exhaustive than the 128-cell typology, the increased manageability that results from the smaller typology is worth the few empirical cases that might not easily find a home in the smaller typology. The 16-cell typology formed by combining four core dimensions of sociocybernetic emergence is shown in Table 1. Notice that Table 1 does permit the

(Table 1 about here)

classification of the prominent types of emergence that have been discussed by Buckley, Mihata, Miller, and Luhmann. The identification of these types in Table 1 is generally straightforward and unambiguous. Traditional emergence is nested, whether an extended hierarchy is identified or not. The first two columns of Table 1 are not nested. Luhmann (1995, pp. 22-23) implied that top-down emergence would result in a non-nested hierarchy. Luhmann's types could occupy cells 10 and 14, probably cells 2 and 6. But since Luhmann implied that non-nested hierarchies would only result form top-down emergence, cells 1, 5, 9, and 13 are probably null, and I will leave them empty.

Column 3 of Table 1 comprises bottom-up, nested emergence, and this is the most familiar and traditional type. cell 7 has been stressed by Buckley, and recognized by Mihata and Luhmann. Cell 11 constitutes new-variable emergence, as presented by Miller and Mihata, while cell 15 represents Miller's transformational emergence (for example, emergence based on increased age or size). While bottom-up new variable emergence has not been recognized for two-level hierarchies (cell 3), it may be logically possible. Since Luhmann implies that top-down emergence leads to non-nested hierarchies, I have left cells 4, 8, and 12 unidentified.

Although cell 16 has not been identified in the emergence literature, it is quite familiar in the business world. Cell 15 (Miller's transformational emergence) is exemplified in the business world by "M and A" (mergers and acquisitions) activity, where businesses merge with another business, and also "swallow" smaller businesses through acquisitions in an aggregative manner. But cell 16 is also empirically recognizable in the business world as the classic “spin-off”, where a large company divides in a top-down fashion to divest a division of group (or previously acquired company) from within its larger company. The difference between cell 14 and cell 16 is that in cell 14, the newly spun-off company is separate and autonomous from the old company, and is no longer owned by it (non-nested), while in cell 16 the newly spun-off company has a new distinct identity (it is a company instead of a division), but remains nested (e.g., a subsidiary). Such spin-offs might also occur in cells 10 and 14 (already recognized by Luhmann), and possibly in cell 12 as well.

CONCLUDING REMARKS

Our typology is helpful in clarifying the similarities and differences among the types of emergence found in the literature. Without a typology or similar framework to compare types, a neophyte reading the literature of sociocybernetics and social systems theory might be confused when encountering the quite different views of emergence presented by Buckley, Miller, and Luhmann, for example. In addition to providing a comparative framework for analyzing disparate types of emergence, the typology also may prove useful in identifying new types of emergence that have not been stressed in the literature, such as the divisive nested “spin-off” type shown in cell 16.

Yet another use of the typology is as a framework for the analysis of various hypotheses about the phenomenon of emergence, and about relations among types of emergence and among hierarchical levels such as those posed by Minati and Pessa (2002). Minati and Pessa distinguish between three levels of systems inquiry, the phenomenological level, the modeling level, and the meta-modeling level. They say (Minati and Pessa, 2002, pp. viii-ix) that emergence is analyzed at the meta-modeling level. They strongly encourage the study of emergence, stating (p. ix) that “the science and the engineering of the future will be almost exclusively the science and the engineering of emergent phenomena—in a word, of systems, and not of aggregates. Such a circumstance calls for a stronger engagement of systems community in a deep reflection about a number of questions relevant to emergence.”

Among the questions that they pose (Minati and Pessa, 2002, p. ix) are what are the various definitions of emergence, is it possible to develop “many-level” models going beyond the standard dichotomy of microscopic-macroscopic, and is it possible to observe two levels simultaneously? Our typology is relevant in addressing all of these questions and more. Table 1 illustrates different definitions of emergence. Also, cells 9-16 of Table 1 aid in addressing questions about multi-level hierarchies, as does our discussion of Miller’s eight hierarchical levels. Further, as our discussion has shown, it is possible to study two (or more) hierarchical levels at once, and Miller (1978) has done this. I agree completely with Minati and Pessa that the study of emergence, including the analysis of multi-level emergence, will be increasingly important in the future. I hope that my tentative effort towards building a typology of emergence for sociocybernetics and social systems theory as shown in Table 1 is a step in the right direction, and that this work can be expanded and refined in the future.

REFERENCES

Bailey, Kenneth D. (1990). *Social Entropy Theory.* State University of New York Press.

Bailey, Kenneth D. (1994a). *Sociology and the New Systems Theory: Toward a Theoretical Synthesis*. State University of New York Press, Albany.

Bailey, Kenneth D. (1994b). *Typologies and Taxonomies: An Introduction to Classification Techniques.* Thousand Oaks, CA: Sage Publications.

Bailey, Kenneth D. (2005a). "Emergence, Drop-back and Reductionism in Living Systems Theory." *Axiomathes* 15: 29-45.

Bailey, Kenneth D. (2005b). "Integrating the Community Level into Living Systems Theory." Pp. 1-15, Article 05-001, in Jennifer Wilby and Janet K. Allen (eds.), *Proceedings of the International Society for the Systems Sciences,* Cancun, Mexico. (CD-ROM).

Buckley, Walter. (1998). *Society—A Complex Adaptive System.* Amsterdam, Gordon and Breach Publishers.

Geyer, Felix, and Johannes van der Zouwen (eds.). (1986). *Sociocybernetic Paradoxes: Observations, Control and Evolution of Self-Steering Systems."* London: Sage.

Lazarsfeld, Paul F. (1937). "Some Remarks on the Typological Procedures in in Social Research." *Zeitshcrift fur Socialforschung* 6: 119-139.

Luhmann, Niklas. (1989). *Ecological Communication.* Chicago: University of Chicago Press.

Lumann, Niklas. (1995). *Social Systems.* Stanford, CA: Stanford University Press.

Mihata, Kevin. (1997). "The Persistence of 'Emergence'." Pp. 30-38 in Raymond

Eve, Sara Horsfall, and Mary E. Lee (eds.), *Chaos, Complexity, and Sociology.* Thousand Oaks, CA; Sage.

Miller, James Grier. (1978). *Living Systems.* New York: McGraw-Hill.

Miller, James Grier, and Miller, Jessie L. (1992). "Greater Than the Sum of its Parts I. Subsystems which Process Both Matter-Energy and Information." *Behavioral Science* 37: 1-38.

Minati, Gianfranco and Pessa, Eliano. (2002). "Preface". Pp. vii-x in Gianfranco Minati and Eliano Pessa (eds.). *Emergence in Complex, Cognitive, Social, And Biological Systems.* New York: Kluwer.

Poli, Roberto. (2001). "The Basic Problem of the Theory of Levels of Reality." *Axiomathes* 12: 261-283.

Shannon, Claude E., and Warren Weaver. (1949). *The Mathematical Theory of Communication.* Urbana: University of Illinois Press.

Table 1. A Four-Dimensional Table of Emergence

		Not Nested		**Nested**	
		Bottom-Up	**Top-Down**	**Bottom-Up**	**TopDown**
		NYI[1]	Luhmann	B-U N V[2]	NYI
	New	1	2	3	4
Nonhierarchical[7]		NYI	Luhmann	B, M, L[3]	NYI
	Old	5	6	7	8
		NYI	Luhmann	M, M[4]	NYI
	New	9	10	11	12
Hierchical		NYI	Luhmann	M, M&A[5]	Spin-Off[6]
	Old	13	14	15	16

1 = Not Yet Identified

2 = Bottom-up, New –Variable Emergence (New Type)

3 = Buckley, Mihata, Luhmann, Pattern Emergence

4 = Miller, New Variable, Mihata, Evolutionary Emergence

5 = Miller, Transformational Emergence, Mergers & Acquisitions

6 = Divisive Nested Emergence, Exemplified by a Corporate "Spin-Off" (New Type)

7 = Nonhierarchical is the minimal two-level hierarchy, while hierarchical is three levels or more.