STRUCTURE AND FUNCTION IN PHONOLOGY - A SYSTEMS VIEW
Alice Wyland Grundt
University of California, San Diego

Romuald Schild of the Polish Academy of Sciences and a scholar
of Stone Age prehistory of Europe has recently pointed out the in-
creasing contemporary need for the integration of all scientific
knowledge. (Schild, p. 100). Roman Jakobson has specifically
emphasized that 'the relationship between linguistics and the ad-
jacent sciences awaits an intensive examination' and notes that
this idea had already been expressed by Edward Sapir in 1928.
Jakobson comments that the 'problem of interrelation between the
sciences of man appears to be centered upon linguistics' because
of the 'unusually regular and self-contained patterning of lan-
guage and to the basic role it plays in the framework of culture.'
He further remarks that since linguistics is recognized as the
'most progressive and precise among the sciences of man,' it stands
as a methodological model for the social disciplines. (Jakobson,
pp. 25ff).
In addition to the close relationship between linguistics and
such disciplines as anthropology and psychology, Jakobson notes
the striking similarity between the structures of language as an
informational system and the genetic code as an information-carry-
ing system: both are based on discrete components 'which, by them-
selves, are devoid of inherent meaning but serve to constitute the
minimal senseful units, i.e., entities endowed with their own, in-
trinsic meaning in the given code.' (Jakobson, p. 50). These
structural similarities are attributed to the consistently hier-
archical design of the respective messages as their fundamental
integrative principle. Jakobson's observation is a stimulating
one: if the similarities between the genetic and the linguistic
codes are due to the hierarchical design of their respective mess-
ages and not to the physical structure of the messages themselves
- as must be the case since the genetic code is chemically defined
and the linguistic code is ultimately acoustically defined - then
we must be concerned with the properties of hierarchical structure
and organization as such, without reference to specific structural
details of the systems we are comparing.
Although Jakobson claims that the scientific study of lin-
guistics lies at the intersection of the physical/biological sci-
ences on the one hand and the social sciences on the other, i.e.,
that linguistics serves as the interface between them, the prolif-
eration of studies into the nature of hierarchies and complex sys-
tems has not centered specifically around linguistics. Rather, the
consensus of opinion which is rapidly forming with respect to the
general systems theory of hierarchical organization has by-passed
linguistics and has been developing instead in the areas of sub-
atomic and astro-physics, chemistry, biology, sociology, economics,
computer science, education, and psychology. For instance, a sym-
posium on hierarchical structures was held in November, 1968, at
the Douglas Advanced Research Laboratories in Huntington Beach,

California, and included scientists from the areas of astro-physics, biology, philosophy, sociology, computer science, and education. The science of linguistics was not represented. Other examples of the lack of participation in current dialogues involving hierarchical or general systems theory by linguists can be mentioned, even though scientists in other disciplines regularly use linguistic terminology to convey their ideas. If linguistic science is to lead the way in theory and methodology for all the other sciences, we must see to it that it hurries to the head of the line and finds out where everybody is going.

Hierarchy or general systems theory concerns the questions of how complex systems are organized, the relation between structure and function of the same system, and the properties of complex systems in general. Although hierarchical organization of linguistic structures has been recognized for some time, I believe that the currently developing theories regarding the relationship of structure and function in complex systems is of immediate and fundamental importance to linguistic theory, particularly in the field of phonology.

One of the most important conclusions that general systems theory has come to is that the structure of any system cannot be derived from a knowledge of its functions nor the functions from a knowledge of its structure. A simple analogy or two should make this clear: if we confine a gas in a closed chamber, we can measure the pressure of the gas, yet the force we define as pressure is not the result of adding together the individual pressures of the gas molecules since each particle as such does not have pressure, only random motion. Again, suppose that you are caught in a traffic jam. You cannot define a traffic jam except in terms of the interactions of a number of vehicles taken as a whole; the traffic jam does not exist as a trait of the individual driver or vehicle nor of the interaction of any two vehicles such that the sum of these traits would equal the 'traffic jam.' The traffic jam is a property of the entire collection of vehicles which emerges when a particular level of vehicle interaction occurs.

The most common and concrete concept associated with hierarchical organization is the concept of discrete but interacting levels. We may conceptualize this idea by using Herbert Simon's metaphor of a set of Chinese boxes of a particular kind: 'opening any given box in a hierarchy discloses not just one new box within, but a whole small set of boxes; and opening any one of these component boxes discloses a new set in turn, but while the ordinary set of Chinese boxes is a sequence, or complete ordering, of the component boxes, a hierarchy is a partial ordering - specifically, a tree.' (Simon, p. 5). The problems associated with the levels concept include: what generates these levels? Why are the levels discrete? What separates the levels? What couples them together? In sum, what is the character of the interface between levels, how does it function, and how does hierarchical control operate between levels? We must be particularly interested in these questions since, as pointed out by Benveniste, 'a

linguistic unit may be conceived as such only insofar as one can
identify it within a higher unit.' (Quoted in Jakobson, p. 51).

The problem of structure and function can be stated as one of
alternate descriptions of the same phenomena, analogous to the
equations of quantum physics where the position and the velocity
of a particle cannot be simultaneously determined but the relation-
ship between these two possible descriptions is expressed by the
Heisenberg Uncertainty Relations. The nature of alternate descrip-
tions can, therefore, be restated as static and dynamic descrip-
tions of the same phenomena which are complementary.

The dynamic description of a system which is self-maintain-
ing defines the relationships of the first-order components of that
system; that is, the set of boxes we see when we open one of our
Chinese boxes. The first-order components themselves, while each
may contain another set of boxes, are necessarily treated as stable
units. We may call this a single level of organization. The re-
lationships of the first-order components, however, require adap-
tive interaction to qualify as a system. Their interactions are
conservative in that their constant mutual adaptation results in an
equilibrium which allows stable properties of the system as a whole
to emerge. The maintenance of these stable properties allows the
system to be treated as a stable unit, functioning as part of the
internal mutually adapting structure of the next higher level of
organization in a complex system composed of nested systems. In
this way, an element can be treated as an independent integrated
system at one level and simultaneously as an adaptive part of the
internal structure of another system at the next higher level of
organization.

If the first-order components exceed two in number, their in-
terrelationships in terms of mutual adaptation in the context of
the entire system can only be understood mathematically in terms
of pairwise interactions. In fact, it has been shown that a set of
differential equations representing the changes in the internal
interactions of a system cannot be added together to arrive at the
pattern of change in the system as a whole. That is, it can be
mathematically shown that the system considered as a whole is not
reducible to the simple sum of the properties and functions of its
parts since the equation which describes the changes in the sys-
tem as a whole is different in form from the set of equations for
the changes in the internal interactions. (Laszlo, 1974, p. 212).

The description of the dynamic interactions, then, consti-
tutes the dynamic description of a system while the description
of the properties of that system taken as a whole represents the
static description of the system.

To make these abstract statements clearer, let us consider
the analogy of a marriage. Within a marriage the relationship of
the two partners in terms of dominance may vary, depending on cir-
cumstances, but will reach a stage of relative equilibrium and we
can speak of a 50-50 marriage, a 60-40 marriage, or even a 90-10
marriage. At all times the sum of the dominance percentages is
equal to 100% but the properties of the marriage taken as a whole

cannot be derived from knowing the ratio of dominance. A master-slave relation such as the 90-10 marriage may be a peaceful one or an angry one but we can't predict which it will be.

The fact that we add together the relative dominance percent-ages to arrive at the total of 100% or unity reflects the reason for the cohesiveness of such a relationship: the mutual adapta-tions which result in equilibrium are undertaken in terms of a larger unit whose integrity must be maintained. If each partner did as he or she liked without reference to the other, we would not have a mutually adaptive relationship, that is, no real mar-riage would exist. The familiar phrase, the 'give-and-take of marriage' reflects the common understanding of this kind of in-ternal structure of an external unity.

The static description defines the properties of the whole system in terms of which it may participate as part of the struc-ture of the next higher level of organization. For example, our married couple may be considered by the law as a unit for tax purposes: the total income of a marriage may be taxed at a rate different from that for the total income of a single person. At this level of organization, the law ignores the internal relation-ships established by the marriage partners in terms of which earned more money than the other. If the law could not ignore such de-tails of structure, it could not organize its tax system hierarchi-cally since every income-earning individual would have to be con-sidered simultaneously in terms of his or her financial inter-actions with every other individual in the system which the tax law governs.

Hierarchical organization involves two kinds of structure: internal structure or the relationships between components at a single level, and external structure or the relationships existing between levels. Hierarchical organization allows the progressive integration of many simpler systems into fewer and fewer but more and more complex systems and presupposes at every level the stabi-lity of the units which make up its nested internal systems. Such an organizational scheme allows for partial internal restructuring without destroying the entire complex system. Thus, when we have opened the lowest level of Chinese boxes, we will have a great many elements but the integration of these elements into larger and few-er sets will contribute to the stability of the system as a whole since we can decompose a box at any level into its component boxes without destroying the system.

For example, if our married couple decides to dissolve their marriage, they have in effect decomposed the marriage unit into its component parts, two individual people, which we may regard as the lowest level of organization in terms of the law. However, the dissolution of a marriage - that is, a loss of a level of or-ganization - will not destroy the social system which the law governs since the decomposition of the marriage into its compon-ent parts affects only that subsystem, and its component parts merely descend to the next lower level and increase that level's population and their interactions.

If we must consider that a change of any component at any level of a complex system will directly affect every other component, we do not have a hierarchical complex system at all but a simple one with a great many interacting components at one level of organization. The more levels of organization within a complex system, the more stability it will have. In fact, the stability of the American political system can be attributed to the many levels of organization it contains: city, county, district, region, state, and nation.

A component of any system may simultaneously function as a component of other systems and will be constrained to adaptive interaction in those other systems. For instance, the husband of our married couple may simultaneously be a member of a professional organization, an office worker, a community leader, and a father. In all of these situations, he must make adaptations in order to maintain relationships. We will require different system descriptions for each activity that the husband engages in. This kind of simultaneous participation in a variety of separate distinguishable activities in separate distinguishable systems is characteristic of biological systems with their stratification into many levels of organization (Rosen, p. 59), and reminds us of the similarities which Jakobson and others have observed between biological and linguistic structures.

It may appear from the foregoing that I am stating the obvious and that linguistic theory has incorporated the insights of hierarchy theory, especially in the generative approach to linguistic analysis. It is certainly true that transformational grammarians propose a tree structure as a model for representing the grammatical relationships in a sentence and each bifurcation can be understood as an organizational level. However, the only structure that is considered is the external one, i.e., the relationships between levels, and does not provide for a way of understanding and representing the relationships of components which interact at the same level of organization.

Langacker has recently noted that transformational theory regards all the clauses in a tree structure as comparable in function. He has, accordingly, proposed the concept of functional stratigraphy which claims 'that the clauses or propositions of a sentential structure differ in function in a way that correlates with their relative depth of embedding, or stratigraphic layering.' (Langacker, p. 2). Langacker's proposal for a hierarchically organized semantic structure is appropriate since external descriptions can only be functional ones, not structural. (Rosen, p. 51).

Similarly in phonological theory the generativists do not allow for considering the interrelationships of elements at the same level of organization nor the possibility of systematic hierarchical structuring of the phonological component. The theory of natural classes based on the intersection of the distinctive features does form a hierarchy but only a taxonomic one since it merely postulates a system of elements held together by the inclusion relation and does not consider the aspects of dynamic interaction which

must be present by definition if a true system exists. The Chomsky/
Halle approach to phonological analysis assumes a simple set of
fundamental components, the distinctive features, and describes
their distribution by means of phonological rules which may be read
as either process statements or distribution statements. The de-
vice of the abstract underlying representation reflects the reso-
lution of conditioned and unconditioned elements to the uncondi-
tioned member, and the ordering of the phonological rules is an
attempt to combine the methodology of internal reconstruction
which infers chronology in sound change with the effects of ana-
logical restructuring, even though these two kinds of phonological
change take place on entirely different bases: true sound change
takes place on the basis of phonetic interactions while analogical
change takes place on the basis of morphological functions.

When generative grammar was first proposed, it was assumed
that a parallelism in structure existed between the syntactic com-
ponent and the phonological component: each included a base or
deep structure level which was related to its surface structure
level by a set of ordered rules. Apparently in the interests of
what was considered to be an appropriate index of simplicity, it
was proposed that the number of significant linguistic levels
should be reduced to two: the base or underlying level and the
surface level. All intervening levels that might be created by
the actions of the rules were specifically designated as linguis-
tically insignificant. The interfaces between the semantic com-
ponent, the syntactic component, the phonological component, and
the phonetic component were not elegantly thought out and the dif-
ficulties of locating the division between semantics and syntax
are currently of major interest. In phonology the readjustment
rules which appear to function as the interface between syntax and
phonology are also a source of difficulty. The most famous result
of abolishing levels of organization in the phonological component
was the destruction of the autonomous phoneme. Since all later
phonological theories which have been proposed are derivatives of
the Chomsky/Halle hypothesis, it will be useful to consider the
basic assumptions of that theory.

The first basic assumption that distinctive features may be
determined on the basis of acoustic and/or articulatory criteria
without reference to a specific language system is equivalent to
saying that the function of a particular kind of speech sound can
be determined from its structure alone. This assumption contra-
dicts the findings of every other scientific discipline, all of
which agree that structure and function are incomparable and the
one may not be derived or inferred from the other. In general,
the error of this assumption has not caused major difficulties in
analysis although a number of scholars have observed that various
aspects of the distinctive feature theory are inadequate or force
the writing of unnecessarily inelegant and clumsy rules. It is
more likely that the distinctive feature system as proposed has
instead limited the kind of phonological problems which can be
solved with it. Y. R. Chao in his famous 1934 article has clearly

presented the arguments against assuming that there can be distinctive speech elements - whether phonemes or distinctive features - which can be determined independently of any specific language system.

Although generative phonology when it was first proposed seemed to offer an elegant and fruitful method for understanding and solving phonological problems, it has come under increasing attack from a number of scholars. Where the difficulty lies is not at all clear: the problem has been sought in the depth of the underlying representation, in the nature of rule ordering, in the formalism proposed, and in the nature and number of distinctive features. These difficulties indicate that the theory as a whole has a more basic flaw. Unless we can locate that flaw and remedy it, we are in danger of seeing phonology as a field of inquiry dwindle into a sterile and trivial exercise.

Chomsky and Halle's assumption that simplicity of structure, that is, reduction of levels, is equivalent to simplicity of organization is again equivalent to saying that the function of any entity can be derived from a knowledge of its structure. The device of organizing a set of components by means of ordered distribution statements is a particularly inefficient method of accounting for relationships. This was the early method employed in computer programming when it was thought to be the most economical approach to the problem of information storage and retrieval. However, it became increasingly clear that a more efficient method must be developed and computer programming is now being done on a module basis, essentially a hierarchical organization of components which can be partially decomposed and reprogrammed without having to search through the entire set of ordered instructions and having to consider the interrelations of all those instructions at one time. This new approach is called 'structured programming.' From this example, we may suspect that a far more efficient way of organizing the phonological component would be to postulate as many intermediate levels of organization as possible in order to allow for partial restructuring without endangering the system of relations as a whole and in order to ensure the greatest possible stability of the system. One of the continuing complaints, in fact, has been that generative phonology does not provide a way of accounting for the syllable and the disyllabic sequence as phonological units, both of which would represent progressively integrated intermediate levels of organization. (Grundt, Lehiste)

One way of demonstrating the need for assuming intermediate levels of organization in the phonological component would be to show that the assumption of self-maintaining subsystems with internal structure in equilibrium and external adaptation to co-occurring subsystems will allow the solution of formerly insoluble problems and can integrate and account for sound changes which were thought to be unrelated and unmotivated.

I have argued at length elsewhere (Grundt 1973, 1974, 1975a, 1975b) that open syllable lengthening in Germanic languages was

motivated by the need of a disyllabic sequence to maintain its integrity as a speech timing unit by means of compensatory internal durational adjustments: when the second vowel of the disyllabic unit was shortened and reduced, the first vowel increased in duration in proportion, thus changing the internal structure of the disyllabic sequence but allowing the maintenance of the sequence as a timing unit. In other words, the durational ratio between the vowels changed by compensatory mutual interaction of co-occurring entities at the same level of organization. At the same time the lengthening vowel considered as a unit with particular functional properties was in danger of losing its functional ability to contrast with the old long vowels in open syllables, a function required by the morphological system. But the means by which the change in durational ratio with the second vowel was implemented, that is, by the formation of a falling centering diphthong, also functioned as a means of differentiating the lengthening vowel from the old long vowels. The old long vowels, in their turn, reacted simultaneously to the lengthening vowels by mutually adapting reciprocal formation of rising diphthongs. This can be analyzed at every point as a set of pairwise interactions, each of which has two different aspects: in terms of the first change, the second change is a reaction, but in terms of the third change, the second change is an innovation; and this chain of interactions can continue until an equilibrium within a larger system is established. Also, at every point the changes can be defined in terms of both dynamic interactions and functional contrast, thus satisfying the general systems hypothesis that every system has two descriptions, a structural and a functional one. Furthermore, since the final vowels in disyllabic sequences were reduced to schwa, they thus lost their contrastive function in that position. But the morphological system required that contrast of short vowels in final position since its inflectional system was based on it. The loss of this functional ability to contrast in final position was catastrophic in English: during the Middle Ages the entire grammar changed, all inflectional morphemes except consonantal ones were lost and word order became far more rigid in compensation, thus illustrating that every higher organizational level must have stable units comprising every lower level in order to remain stable.

Another reason to suppose that the short vowels and the long vowels form related but self-maintaining subsystems within the vocalic component is the fact that, when the morphological system no longer required the old contrast of long and lengthened vowels in open syllables, they merged in the long system. However, the lengthened vowels did not merge with the long vowels to which they corresponded in former long-short alternations as in wild/wilderness, ride/riden but with those vowels which were one vowel height lower. Acoustic studies in modern Faroese and Cologne German have shown that the short vowels are not merely slightly lower and centered versions of the long vowels but actually coincide in their formant patterns with the long vowels one degree

lower: /i/ = [e], /e/ = [ε], /ε/ = [æ]. This means that the long
and short vowels which had the same function in their respective
systems had drastically different phonetic realities: the iso-
functional members were not phonetically equivalent and, therefore,
the functional and structural descriptions of the same set of for-
mant frequencies were different.

It is clear that this analysis agrees with the general sys-
tems theory of hierarchical organization in complex systems since
the changes were motivated by the need to maintain the integrity
of a larger unit, they were implemented by mutually adapting in-
teractions, the functional and phonetic descriptions of the same
phenomena were different, and finally the changes can be analyzed
as pairwise interactions at every point. This approach allows the
motivation and interrelation on both phonetic and functional grounds
of open syllable lengthening, long vowel diphthongization, and vowel
height exchange. Neither the motivation nor the interrelatedness
of these changes can be accounted for in generative phonological
theory because that theory does not provide for intermediate levels
of organization nor any means of understanding and describing the
interrelations of components occurring at the same level of organ-
ization. It is obvious that, if a particular entity has a differ-
ent description for its structural and its functional correlates,
it cannot be described with one system of distinctive features.
Such features can only describe the functional aspect. The phon-
etic reality of these functional features must be separately deter-
mined and specified. Historical linguists have always assumed
this to be true.

The assumption of intermediate levels of organization and
adaptive interrelated subsystems at each level will account for all
the changes that are accounted for in generative phonological theory,
will restore the autonomous phoneme to a respectable place in the
hierarchy, and can account for and interrelate sound changes that
have been unrelated and unmotivated before. It also demonstrates
the crucial need to keep functional and structural descriptions
distinct since each element has a functional and a structural des-
cription which are different and non-comparable. The ignorance of
this fundamental fact is the source of all the difficulties with
the generative theory: in distinctive features, in reduction of
levels, and in the theory of rule ordering.

Finally, the general systems theory of hierarchical organiza-
tion satisfies the scientific criteria of simplicity since the or-
ganizational principle is very simple, yet can result in ordered
and highly complex systems. The principle is essentially this:
in conservative self-maintaining systems, the systems functioning
as wholes on one level function as parts on the higher levels,
and the parts of a system on any level (with the exception of the
lowest or 'basic' level) are themselves wholes on lower levels.
(Laszlo, 1972a, p. 51). The interfaces between the levels are dis-
crete because the means of forming more and more complex organiza-
tional levels are themselves discrete.

Jakobson has commented that natural languages share with biological systems the characteristics of structural regularities, dynamic equilibrium, and cohesive power. (Jakobson, p. 53). The similarities in structure are due to a common principle of organization of hierarchical complex systems, and the cohesiveness of such systems is due to the dynamic equilibriums which must be maintained at each level in order to ensure the stability of the whole. It would appear that Romuald Schild's call for the integration of all scientific knowledge can best be implemented by the use of the one principle that all current research indicates the sciences have in common: hierarchical organization of complex systems.

References:

Bloom, Allan M. 1975. The 'else' must go, too. Datamation (May). 123-128.

Broglie, Louis, Prince de. 1953. The revolution in physics - a non-mathematical survey of quanta. The Noonday Press.

Chao, Yuen-Ren. 1934. The non-uniqueness of phonemic solutions of phonetic systems. Bulletin of the Institute of History and Philology, Academia Sinica, Vol. IV.4.363-97. Also in Readings in Linguistics I, Martin Joos, Ed., 1957, Univ. of Chicago Press, 38-54.

Chomsky, N. and M. Halle. 1968. The sound pattern of English. New York: Harper and Row.

Dijkstra, E. W. 1968. GOTO statement considered harmful. Communications of the ACM, Vol. II.3.147-148. (March)

Donaldson, James R. 1973. Structured programming. Datamation. (December). 52-54.

Frost, David. 1975. Psychology and program design. Datamation. (May). 137-138.

Grundt, Alice Wyland. 1973. Open syllable lengthening in English: a study in compensatory phonological processes. Ann Arbor: University Microfilms.

Grundt, Alice Wyland. 1974. Old English vowels and the question of vowel heights. Paper given at LSA Convention, New York City.

Grundt, Alice Wyland. 1975a. Tonal accents in Low German. Proceedings of the First Annual Meeting of the Berkeley Linguistics Society, Vol. I.160-169.

Grundt, Alice Wyland. 1975b. Compensation in phonology. Mss.

Heike, Georg. 1964. Zur Phonologie zur Stadtkölner Mundart. Marburg: N.G. Elwert Verlag.

Jakobson, Roman, C. Gunnar M. Fant and Morris Halle. 1967. Preliminaries to speech analysis: the distinctive features and their correlates. Cambridge: The MIT Press.

Jakobson, Roman. 1973. Main trends in the science of language. New York: Harper Torchbooks.

Langacker, Ronald W. 1975. Functional stratigraphy. To appear in: Robin Grossman et al (eds). Papers from the Parasession on Functionalism. Chicago Linguistic Society. 1-47.

Laszlo, Ervin. 1972a. Introduction to systems philosophy. New

198

York: Harper Torchbooks.

Laszlo, Ervin, ed. 1972b. The relevance of general systems theory. New York: George Braziller.

Laszlo, Ervin. 1972c. The systems view of the world. New York: George Braziller.

Laszlo, Ervin. 1974. A strategy for the future. New York: George Braziller.

Lehiste, Ilse. 1960. Segmental and syllabic quantity in Estonian. American Studies in Uralic Linguistics, Indiana University Publications, Uralic and Altaic Series, Vol. I. Bloomington. 21-82.

Lehiste, Ilse. 1971. Temporal organization of spoken language. Form og substance, phonetic and linguistic papers presented to Eli Fischer-Jørgensen. Odense: Akademisk Forlag. 159-169.

McCracken, Daniel D. 1973. Revolution in programming: an overview. Datamation (December). 50-52.

Miller, Edward F., Jr. and George E. Lindamood. 1973. Structured programming: top-down approach. Datamation (December). 55-57.

Pattee, Howard H., ed. 1973. Hierarchy theory: the challenge of complex systems. New York: George Braziller.

Rischel, Jørgen. 1964. Toward the phonetic description of Faroese vowels. Fróðskaparrit 13.99-113.

Rosen, Robert. 1972. Some systems theoretical problems in biology. In: The relevance of general systems theory, Ervin Laszlo, ed. New York. 43-67.

Schild, Romuald. 1976. The final paleolithic settlements of the European plain. Scientific American, Vol. 234.2.88-100.

Simon, Herbert A. 1973. The organization of complex systems. In: Hierarchy theory, Howard H. Pattee, ed. New York. 1-28.

Whyte, Lancelot Law, Albert G. Wilson, and Donna Wilson. 1969. Hierarchical structures: Proceedings of the symposium held November 18-19, 1968, at Douglas Advanced Research Laboratories, Huntington Beach, California. New York: American Elsevier Publishing Co.

STRUCTURE AND FUNCTION IN PHONOLOGY - A SYSTEMS VIEW
By: Alice Wyland Grundt, Univ. of Calif., San Diego

Model of a Multi-Strata (Multi-Level) System:

(Taken from: Mesarovic̆, M. D. and D. Macko. 1969. Scientific
theory of hierarchical systems. In: Hierarchical structures,
Whyte, Wilson and Wilson, eds. American Elsevier Publishing Co.
29-50).

Stratum 4

Stratum 3

Stratum 2

(Each element
is a subsystem
on Strata 3,
a system on
Strata 2)
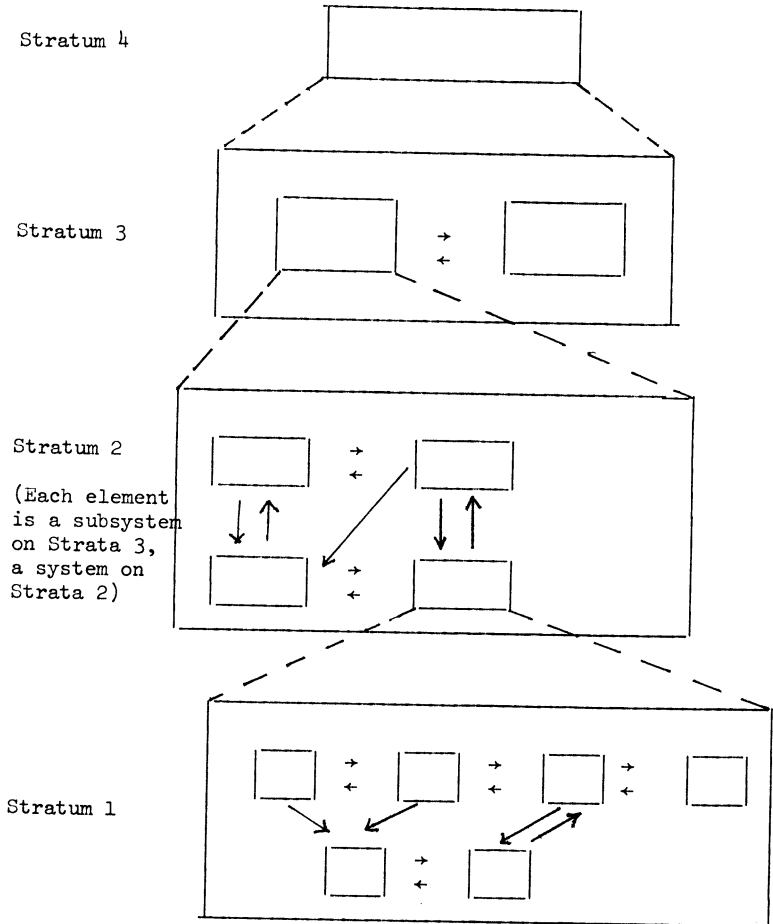
Stratum 1

Structure and Function in Phonology - a systems view
Alice Wyland Grunct, UCSD

<u>Mesarović and Macko, p. 34</u>. 'On any given stratum, the behavior
of the corresponding systems are studied in terms of their inter-
nal operation and evolution, while the question of how these sys-
tems interact so as to form a higher stratum system is studied on
that higher stratum....this object-system relationship between
descriptions on various strata leads to a hierarchy of appropriate
description languages. Since for each stratum there is given a
different set of concepts and terms to be used for the description
of the system on that stratum, there exists in general a different
language.'

<u>Germanic vowel changes</u>: open syllable lengthening, final vowel
reduction, long vowel diphthongization
vowel height exchange

Stage 1 $V_1 \underset{\leftarrow}{\rightarrow} V_2 /\#C\_\_C\_\_\#$ (stable vowel duration
ratio maintained)

Stage 2
(e.g., /e/
is lengthened)

a. $V \rightarrow [\ni] / \#CVC\_\_\#$

b. $\{ /e/ = [\varepsilon] \rightarrow [é\ni] /\#C\_\_C\ni\# \}$

c. $\{ /e:/ = [e:] \rightarrow [æé] \}$

d. $/\varepsilon:] = [\varepsilon:] \rightarrow [éi] \}$

Note: 2-a is an innovation with respect to 2-b but a reaction
with respect to an earlier change not considered here.
2-b is a reaction with respect to 2-a but an innovation
with respect to 2-c.
2-c is a reaction with respect to 2-b but an innovation
with respect to 2-d.
At 2-d it is assumed that equilibrium of the long and
lengthened vowel subsystems has been established.

This analysis is supported by reflexes in the Soest dialect of
Low German. (Holthausen, F. 1886. Die Soester Mundart. Diedrich
Soltau's Verlag).

Structure and Function in Phonology - a systems view
Alice Wyland Grundt - UCSD

Vowel Subsystems in Soest (Westphalian) Dialect of Low German
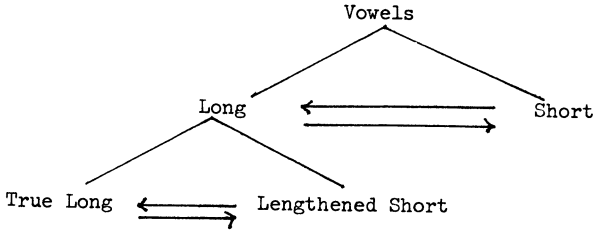
Old long vowels:

UI	IU
ɔɛ	ɛɔ
aɛ	aɔ
ɛ:	ɔ:

Lenthened short vowels:

iə	yə	uə
ea	öa	oa
	a:	

Short vowels:

I	Y	U
ɛ		ɔ
	a	

Sources:

MLG	Soest
i:, ü:	UI
u:	IU
e:	aɛ
ɛ:, ä	ɔɛ, ɛ:
a:	ɔ:
ɔ:, ö	ɛɔ, ɔɛ
o:, ö:	aɔ, aɛ