

1. *An overview.* The aim of this paper is to sketch a framework for describing systems of inflectional morphology. In so doing I shall be making many implicit claims about the nature of language - not merely about a convenient formalism for stating generalizations and listing idiosyncratic facts - but the focus of my presentation here will be simply to show how the framework can be applied to some reasonably complex arrays of inflectional forms.

My intellectual debts in this enterprise are considerable. First, to the work of Peter Matthews (1965, 1972), Stephen Anderson (1977, 1982), Rich Janda (1983), and others who have resuscitated process morphology within modern approaches to formal grammar. Second, to Andrew Carstairs (1981, 1983), Wolfgang Wurzel (to appear), Fred Karlsson (to appear), and other writers who have stressed that paradigms are not mere arrays of forms, but have internal organization of considerable interest. Third, to Paul Hipsky (1982a, b) and other proponents of 'lexical' morphology and phonology, whose work (along with Anderson's) raises urgent questions about the relationships among syntax, inflectional morphology, derivational morphology, phonology, and the lexicon.

My focus is on what have been called, by various writers, *rules of allomorphy* or *morpholexical rules*, insofar as they concern inflectional morphology. Since the terminology in these matters is somewhat confused, with different writers using these two technical terms in distinct ways, I have opted for the term *realization rules* to refer to principles describing when and how morphosyntactic features are realized as morphological processes. These principles belong in a morphological component [1], which follows a syntactic component, in which (among other things) morphosyntactic features are located within syntactic structures, and precedes a phonological component, in which (among other things) some morphophonemic alternations are accounted for by rules altering phonological representations.

There are, I claim, two types of realization rules. First there are rules of *exponence*, describing how certain combinations of morphosyntactic features are realized, in the context of certain other bundles, as morphophonological operations. The following principle of English is a typical rule of exponence: In the context of [CAT:verb], [VFORM:past] is realized by the suffixation of /d/. Then there are rules of *referral*, stipulating that certain combinations of features have the same realization as certain others. The following principle of English is a typical rule of referral: In the context of [CAT:verb], [VFORM:pastprt] has the same realization as [VFORM:past].

All realization rules are treated as expressing *defaults*, which are automatically overridden by more specific rules (and these in turn by still more specific rules, and so on). [2]

The framework distinguishes *features*, such as CASE and PERSON, from *clusters of values* that features can take, such as direct versus oblique case, or second versus nonsecond person. And it permits reference to *feature clusters*, such as [CASE-GENDER-NUMBER].

Finally, I assume not only a set of realization rules, but also an ordered set of (abstract) slots for inflectional material. Any particular rule supplies material for a specified slot or slots, and several distinct rules can supply material for the same slot. The ordering of a rule with respect to others is then governed by the ordering of slots.

The main features of the framework can now be listed: (a) rules of referral, as well as rules of exponence; (b) extensive use of default settings; (c) a distinction between features, value clusters, and feature clusters; and (d) a conceptual separation of values and slots. In the remainder of this paper I will develop these proposals in some detail, concentrating on (a) and (b) and illustrating the proposals with a description of a substantial portion of the declensional system of standard German.

2. *Fundamental assumptions and conventions.* I presuppose some analysis of the units of syntax and morphology (constituent types, word classes, base classes) as combinations of feature values, or as *bundles*, as I shall call them. For the moment I make the simplifying assumption that a bundle is simply an (unordered) set of (ordered) pairs, each pair associating to some feature one of its values (or, in some cases, a disjunction of several of its values).

Typographical conventions: names of features are in upper case (GEND); names of values are in lower case (fem); a disjunction of values is indicated by a slash between the value names (nom/acc); a pairing of feature and value is indicated by appending the value name to the feature name, with a colon separating them (GEND:fem); names of pairs are combined by means of a separating comma and space (GEND:fem, CASE:nom/acc); and names of bundles have flanking square brackets ([GEND:fem, CASE:nom/acc]).

It is often convenient to refer to linguistic forms by means of the values that are realized in them - for instance, to refer to forms in which the values CASE:nom, GEND:fem, and NUM:sg are realized as being in (or of) the nom fem sg, or simply as being nom fem sg.

The primary tool in describing inflectional systems is the rule of exponence, the function of which is to realize some bundle, in the context of some other bundle, as a morphophonological operation or operations. [3]

In German, for instance, the bundle [CASE:nom, GEND:masc, NUM:sg], in the context of the feature values picking out the 'strong' declension of determiners and adjectives (which I will suppose for the moment is the bundle [CAT:det/adj, CLASS:str]), is realized by the suffixation of *-er* to a base, as in *dies-er Mann* 'this man' and *ein alt-er Mann* 'an old man'.

3. *Syncretism.* I begin the main exposition with the observation (stressed by Carstairs) that syncretism is very common in inflectional paradigms. Consider the 'weak' declension paradigm for German adjectives, given in Table I. Although there are four values for CASE (nom, acc, gen, dat), three for GEND (masc, neut, fem), and two for NUM (sg, pl), making a total of 24 distinct bundles involving these three features, there are only two distinct forms in the paradigm, *-e* and *-en*.

	MASC-SG	NEUT-SG	FEM-SG	PLURAL
NOM	-e	-e	-e	-en
ACC	-en	-e	-e	-en
GEN	-en	-en	-en	-en
DAT	-en	-en	-en	-en

Table I. Weak adjective endings.

There is both systematic syncretism and accidental syncretism. [4] Consider the German weak declension. Any pl form has the suffix *-en*. So does any gen form. So does any dat form. These syncretisms are systematic, general, regular. On the other hand, the appearance of the suffix *-en* on weak adjective forms in the acc masc sg is an isolated anomaly, not relatable to the appearance of *-en* elsewhere. Nom sg forms have the suffix *-e*, and so do acc sg forms for genders other than the masc.

Saying there is systematic syncretism is saying there are generalizations about whole classes of forms; a paradigm is not merely a list. Classes of forms can then be picked out in a rule by mentioning a bundle in which some values are unspecified or disjunctive. For the German weak declension, we want to say that nom masc sg, nom neut sg, and nom fem sg forms should be picked out as a class and not individually. This could be achieved by having a rule mention the bundle [CASE:nom, NUM:sg]. The rule would then pick out these three combinations and none of the other 21.

4. *Defaults.* To some such generalizations there are classes of exceptions. The rules of exponence can be stated quite generally, but are to be understood as describing defaults.

The appearance of *-en* in the acc masc sg of the weak declension is an exception to a generalization that [CASE:nom/acc, NUM:sg] is realized by the suffixation of *-e*. Rather than abandoning or limiting the generalization, we can preserve it as a statement of a default realization. Thus far we have two rules of exponence:

- (1) In the context of [CAT:adj, CLASS:wk], [CASE:acc, GEND:masc, NUM:sg] is realized by suffixation of /en/.
- (2) In the context of [CAT:adj, CLASS:wk], [CASE:nom/acc, NUM:sg] is realized by suffixation of /e/.

Now the appearance of *-en* everywhere else - in the gen and dat sg and throughout the pl - can be stated as the general default, exceptions to which are described by rule (2):

- (3) In the context of [CAT:adj, CLASS:wk], any bundle of CASE, GEND, and NUM values is realized by suffixation of /en/.

5. *Rule interaction.* The natural principle of rule interaction - a version of Proper Inclusion Precedence or 'elsewhere' application - holds in such cases: the more particular

rule overrides the more general.

By this principle, rule (1) overrides rule (2), because the bundle [CAT:adj, CLASS:wk, CASE:acc, GEND:masc, NUM:sg] is more specific than the bundle [CAT:adj, CLASS:wk, CASE:acc/nom, NUM:sg]. And rule (2) overrides rule (3), because the bundle [CAT:adj, CLASS:wk, CASE:acc/nom, NUM:sg] is more specific than the bundle [CAT:adj, CLASS:wk].

6. *Value clusters.* A representation for the 'internal structure' of features like CASE, GEND, PERS, NUM, CLASS, VFORM, etc. is not necessarily a tree in which each natural class of values falls under a single node, or a chart in which all such classes make contiguous regions. Paradigms are neither trees nor charts.

For any given feature, the clusters of its values that function together in grammars can always be represented in terms of binary features. But achieving such a representation might take as many binary features as there are values. I conclude that we need some direct method for referring to *value clusters*. Indeed, I have already allowed for reference to any stipulated disjunction of values.

On occasion it may be convenient to have names for particular value clusters, such as nom/acc for CASE in German. Certainly some of these value clusters are made available by universal grammar; Jakobson seems to have assumed that they all are, but here I leave the matter open.

In person systems in general, the three persons form grammatically significant classes in all three logically possible ways: PERS:1/2, PERS:1/3, and PERS:2/3 (see Zwicky 1977). The second of these (which does not appear as a contiguous region in the traditional chart presentation of verb paradigms) plays a prominent role in German grammar, since 1 pl and 3 pl forms are always identical (with suffix *-en*), though they are always distinct from the 2 pl (with *-t*), and the default is for 1 sg and 3 sg forms to be identical (with various exponents, depending on the context), though they are always distinct from the 2 sg (with *-st*). No tree or chart representation makes all three of the groupings 1/2, 1/3, 2/3.

One three-valued feature by itself makes none of these groupings. Binary features make groupings, but it takes three binary features to get all three of the value clusters for PERS. Nothing is gained by this move. I will continue to use the three-valued feature PERS and to refer to these value clusters disjunctively.

In the German case system, the four cases have been grouped (by Bierwisch 1967) into two orthogonal binary sets, 'direct' nom/acc versus 'oblique' gen/dat, and 'subject' nom/gen versus 'object' acc/dat. The first distinction has already appeared in my discussion of weak adjective declension; see rule (2), which mentions CASE:nom/acc. CASE:gen/dat plays a role in strong adjective declension, as we shall see. It is convenient to have names to refer to the two (complementary) value clusters nom/acc and gen/dat; I will use Dir and Obl. Rule (2) can then be restated as follows:

(2') In the context of [CAT:adj, CLASS:wk], [CASE:Dir, NUM:sg] is realized by suffixation of /e/.

(In general, names of value clusters will have initial capitalization, so that they are typographically distinct from names of features and names of values.)

Among the value clusters I shall have occasion to refer to are two for the feature CAT. To see the need for the first, consider the fact that the suffix *-en* as the exponent of the acc masc sg is not restricted to the weak declension of adjectives; the strong declension of adjectives has the same exponent for this bundle, and so do all declinable determiners (nouns do not, in general). The specification CLASS:wk in rule (1) should be eliminated, so that the rule applies to both strong and weak declensions. And the specification CAT:adj should be replaced by CAT:adj/det, so that the rule applies to determiners as well as adjectives. CAT:adj/det must also be mentioned in the rule of exponence, (4), for the masc nom sg in the strong declension (rule (2') will override (4) in the weak). I will use the name Adjal ('adjectival') for the value cluster adj/det:

(1') In the context of [CAT:Adjal], [CASE:acc, GEND:masc, NUM:sg] is realized by suffixation of /en/.

(4) In the context of [CAT:Adjal], [CASE:nom, GEND:masc, NUM:sg] is realized by the suffixation of /er/.

Next, I shall want to refer to the value cluster noun/adj/det, which picks out the full set of categories subject to declension, and in particular to weak declension. There is a small class of masculine nouns, such as *Hirt* 'stag', with *-en* in the gen/dat and the pl, just like adjectives in the weak declension; most nouns can be treated as CLASS:str, but these should be CLASS:wk. I must postpone stating the actual rules. Here I merely record the name Nounal for the value cluster noun/adj/det.

7. VCRs and FVDs. There are general principles governing the distribution of feature values in bundles, whatever the exponents of these values might be. These are of at least two types, value co-occurrence restrictions (VCRs) and feature value defaults (FVDs); see Gazdar and Pullum 1982 on feature cooccurrence restrictions and feature coefficient defaults. VCRs are implicational generalizations about feature values in bundles. FVDs express default assignments of values for features, usually in the context of specified values for other features.

I do not have the space to develop a theory of VCRs and FVDs here, although one VCR, (18), will play a role in the analysis of German I am developing here. The extent to which the content of VCRs and FVDs is universal is again a question of some interest, but not one I shall pursue here.

8. Bare bases. Bare (uninflected) bases are not uncommon, and such materially 'unmarked' forms are typically associated with bundles that are 'unmarked' in the sense of the Prague School and Greenberg.

The simplest treatment of such forms is to assume that they have been unaffected by any rule. Bare bases are then the ultimate defaults; they are what's left when nothing happens.

Most German nouns have only a few forms with overt exponents of their feature values. The standard feminine noun, for

instance, has no exponents at all in the singular, and the suffix *-en* throughout the plural; *Frau* 'woman', plural *Frauen*, is typical. The standard neuter noun has distinct suffixed forms in the oblique cases of the singular (*-(e)s* in the gen sg, *-(e)* in the dat sg), but the base in the direct cases: neut nom/acc sg *Buch*, gen *Buchs*, dat *Buch(e)*.

I assume that the base forms here result from the nonapplicability of any rule of exponence. A form like *Frau* or *Mann* is what is left when rules of exponence like the following do not apply.

- (5) In the context of [CAT:noun], [CASE:gen, GEND:neut, NUM:sg] is realized by the suffixation of /es/.
- (6) In the context of [CAT:noun], [CASE:dat, GEND:neut, NUM:sg] is realized by the suffixation of /e/.

On this account, nom/acc/gen/dat sg *Frau* results from the fact that rules (5) and (6) do not affect fem nouns; and nom/acc neut sg *Buch* results from the fact that these rules affect only gen/dat, not nom/acc, nouns.

I do not reject the possibility that some zero formations are stipulated by rule. I am, however, assuming that the normal source for zero formations is the absence of any rule providing an exponent for certain bundles.

9. *Rules of referral.* There are generalizations referring the selection of exponents for one bundle to those for another (in some context); these rules of referral may have exceptions (may describe defaults), and if so they are overridden by the rules describing the exceptions.

	MASC-SG	NEUT-SG	FEM-SG	PLURAL
NOM	-er	-es	-e	-e
ACC	-en	-es	-e	-e
GEN	-en	-en	-er	-er
DAT	-em	-em	-er	-en

Table II. Strong adjective endings.

Consider in this light the strong declension of adjectives, summarized in Table II. Look at the acc sg forms. As in the weak declension, the masc has *-en*; rule (1') already predicts this. The neut has *-es*, the fem *-e*, and these suffixes are respectively identical to the nom neut sg and the nom fem sg; in addition the acc pl and nom pl both have *-e*. Each of these identities could be described by a rule of exponence covering two forms, but such a description would treat the nom/acc neut sg identity and the nom/acc fem sg identity as unrelated. Rather, we should want to say that there is a nom/acc identity, period.

The formal identity of nominative and accusative extends to strong-declension (which is to say, nearly all) nouns, where it holds even for masculines. The nom/acc sg form of these nouns is

their base form, with no suffix (masc nom sg *dieser Mann*, acc nom sg *diesen Mann*); the nom/acc pl form of these nouns is simply their plural form (nom/acc pl *diese Männer*).

Finally, the formal identity of nom and acc extends to a subtype of the strong declension for determiners, exhibited by determiners like *mein* 'my'. Here the nom/acc fem sg and the nom/acc pl have *-e*, just as for determiners like *dieser*, but the nom/acc neut sg have the base form (as does the nom masc sg): sg *mein Buch* versus *dieses Buch*, but pl *meine Bücher* and *diese Bücher*.

The nom/acc identity thus holds for all strong nouns. The question is now how the identity is to be stated. As I pointed out above, if we insist (as, for example, Bierwisch does in his analysis of German declension) that formal identities are to be described by rules of exponence, however general, then we are stuck with a separate rule for each exponent, and generalizations are missed. We need to say directly that two different bundles have the same realization, whatever that is.

But in order to do this we must specify how one of these bundles is realized. It is not enough to say that two things are the same, without saying what either of them is. In the case at hand, we must specify either the nom sg, or the acc sg, or sometimes one and sometimes the other.

There are in fact two sorts of indications that one category should be taken as primary in such situations. The first is the existence of clearly exceptional formations, like the *-en* of the masc acc sg in German. In some sense, this form 'ought to' have the *-er*, *-e*, or zero of the nom sg. The second indication comes from zero exponents, where I have claimed that in the normal situation the absence of an exponent results from the failure of any rule to supply an exponent. The zero in the nom masc/neut sg of *ein*-words is a case in point. The fact that *-en* appears in the acc masc sg and zero in the nom masc sg means that the acc cannot be taken as primary, for then the nom masc sg would also get *-en*. Instead, the nom must be taken as primary:

(7) In the context of [CAT:Nounal], [CASE:acc] has the same realization as [CASE:nom].

The rule of referral in (7) mentions both context value (CAT:noun/adj/det and CLASS:str) and realized values (CASE:acc), and specifies a set of referral values (CASE:nom). The rule is applied as follows: Given a bundle *B* containing both the mentioned context values and the mentioned realized values; construct a new bundle *B'* by substituting the referral values for whatever values these features have in *B* (here, substitute the value nom for acc), and then realize *B'*. The effect of (7) then depends on rules of exponence for nominatives; in particular, it depends on the existence of the two following rules of exponence, and the absence of any rules affecting nom sg nouns.

(8) In the context of [CAT:Adjal], [CASE:nom, GEND:neut, NUM:sg] is realized by the suffixation of /es/.

(9) In the context of [CAT:Adjal], [CASE:nom, GEND:fem, NUM:sg] is realized by the suffixation of /e/.

Now consider the full set of case forms for masc and neut sg *ein*-words. The acc masc sg has, of course, *-en* (by rule (1')); the acc neut sg is the base form, by virtue of the rule of referral (7) and the absence of any rule of exponence covering the nom neut sg. For the remaining three cases, the masc and neut forms are identical: the nom is the base form, the gen has *-es*, and the dat has *-em*. A rule of referral is called for, and the base form of the acc neut sg (versus the *-en* of the corresponding masc form) indicates that the neuter paradigm is the primary one.

In fact, a rule referring masc sg forms to the corresponding neut sg ones operates for all strong nouns, not just for determiners like *ein* and *kein*. Determiners like *der* and *dieser* are subject to the rule, though it is visible only in the gen and dat (*-es* and *em*, as for *ein*-words); rule (4), for the nom masc sg, and rule (1'), for the acc masc sg, override any rule referring masc forms to neut ones. The strong declension of adjectives is subject to the rule, though again it is visible only in the gen and dat (*-en* and *-em*, respectively); rules (4) and (1') override any rule of referral again. Finally, the strong declension of nouns shows the rule in all four cases: the nom/acc masc/neut sg has the base form, the gen masc/neut sg has *-(e)s* (via rule (5)), and the dat masc/neut sg has *-(e)* (via rule (6)).

I have now argued for one new rule of referral, (10), and mentioned three further rules of exponence: (11), specifying *-es* in the gen neut sg of determiners; (12), specifying *-em* in the dat neut sg of adjectives and determiners; and (13), specifying *-en* in the gen neut sg of adjectives. Rule (3) for weak adjectives will override any of these rules, so that (10)-(13) actually apply only to bundles containing CLASS:str.

- (10) In the context of [CAT:Nounal], [GEND:masc, NUM:sg] has the same realization as [GEND:neut].
- (11) In the context of [CAT:det], [CASE:gen, GEND:neut, NUM:sg] is realized by the suffixation of /es/.
- (12) In the context of [CAT:Adjal], [CASE:dat, GEND:neut, NUM:sg] is realized by the suffixation of /em/.
- (13) In the context of [CAT:adj], [CASE:gen, GEND:neut, NUM:sg] is realized by the suffixation of /en/.

For determiners and adjectives, what remains to be described are a pair of fem forms and all the pl forms. The first is straightforward: *-er* realizes the gen/dat fem sg:

- (14) In the context of [CAT:Adjal], [CASE:Obl, GEND:fem, NUM:sg] is realized by the suffixation of /er/.

In the pl, the pattern of forms is identical to those in the fem sg (nom/acc *-e*, gen/dat *-er*), with the exception that the dat pl is always *-en* (rather than *-er* as in the fem sg). By the same reasoning that led us to take nom, rather than acc forms as primary above, we select the fem sg forms as primary here, referring the pl forms to them; this is the rule of referral in (16). The dat pl is exceptional and needs its own rule of exponence, (15). Both (15) and (16) apply to nouns as well as adjectives and determiners, though this will not be obvious until the discussion of slots in section 14.



- (15) In the context of [CAT:Nounal], [CASE:dat, NUM:pl] is realized by the suffixation of /en/.
- (16) In the context of [CAT:Nounal], [NUM:pl] has the same realization as [GEND:fem, NUM:sg].

10. *More on rule interaction.* When two (or more) rules of referral are applicable to the same form, and neither overrides the other, they can be viewed as applying simultaneously. Obviously, rules of referral will feed the rules of exponence they refer to.

In the data presented so far, there are two occasions where two rules of referral are applicable to the same form: in the acc pl of strong adjectives and determiners, where both rule (7) and rule (16) apply; and in the masc acc sg of strong nouns, where both rule (7) and rule (10) apply. The joint effect of rules (7) and (16) is to refer the acc pl to the nom fem sg, and the joint effect of rules (7) and (10) is to refer the masc acc sg to the neut nom sg.

Both referrals are correct. Referring the acc pl of strong adjectives and determiners to the nom fem sg means that the rules of referral feed rule (9), which realizes the nom fem sg of adjectivals as -e; this is right for the acc pl. Referring the masc acc sg of strong nouns to the neut nom sg means that no rule of exponence will be available, and the unaltered base results; this is right for the masc acc sg.

11. *Rule features.* Individual bases can exceptionally fail to undergo a rule (of exponence or referral). I will assume that for each rule there is a feature RULE!N, where N is the name of the rule. Each rule-feature takes the values yes and no, and the default value for all rule-features is yes. A base that exceptionally fails to undergo a rule is lexically specified as RULE!N:no. The consequence of failing to undergo a rule is the appearance of the base form.

This proposal allows us to treat the *ein*-word determiners (*ein, mein, kein, unser*, etc.) just like other determiners in almost every respect. Their only peculiarity is that they fail to undergo rule (8), the rule of exponence for nom neut sg adjectivals. As a result, the nom neut sg has the base form. So does the acc neut sg, which is referred to the nom neut sg by rule (7). And so does the nom masc sg, which is referred to the nom neut sg by rule (10). All this is achieved simply by saying that each *ein*-word is specified RULE!(8):no in the lexicon of German. Indeed, we might say that the class of *ein*-words is definable as the set of German lexical items specified [CAT:det, RULE!(8):no].

I am now in a position to describe the weak declension of masculine nouns like *Hirt*. These have the base form in the nom sg, *-en* elsewhere. Most of their declension can be referred directly to the weak adjective declension:

- (17) In the context of [CAT:noun, CLASS:wk], any bundle of CASE, GEND, and NUM values has the same realization as [CAT:adj].

Rule (17) overrides all the rules that mention only CAT:noun or CAT:Nounal, without mentioning a value for CLASS: rules (5), (6), (7), (10), (15), (16). It correctly refers the acc sg to the

acc sg for weak-declension adjectives, which has *-en* by rule (1'). It correctly refers the gen/dat sg and all pl forms to the corresponding weak-declension adjective forms, which have *-en* by rule (3). However, as it stands, it incorrectly refers the nom sg to the corresponding weak-declension adjective form, which is *-e* by rule (2'). This can be corrected by a general statement (a VCR, in fact) that weak-declension nouns do not undergo rule (2'):

(18) If a bundle contains CAT:noun and CLASS:wk, it also contains RULE!(2'):no.

12. *Feature clusters.* The system of rules presented thus far describes nearly all the declensional forms of German [5]. The realization rules for bundles of CASE, GEND, and NUM values are summarized in Table III; blank cells in the table can be filled with any values for the feature in question, and '>>' stands for the referral relationship.

Rule	CAT	CLASS	CASE	GEND	NUM	Realization
====	===	=====	====	====	====	=====
(1')	Adjal		acc	masc	sg	suffix /en/
(2')	adj	wk	Dir		sg	suffix /e/
(3)	adj	wk				suffix /en/
(4)	Adjal		nom	masc	sg	suffix /er/
(5)	noun		gen	neut	sg	suffix /es/
(6)	noun		dat	neut	sg	suffix /e/
(7)	Nounal		acc			>> CASE:nom
(8)	Adjal		nom	neut	sg	suffix /es/
(9)	Adjal		nom	fem	sg	suffix /e/
(10)	Nounal			masc	sg	>> GEND:neut
(11)	det		gen	neut	sg	suffix /es/
(12)	Adjal		dat	neut	sg	suffix /em/
(13)	adj		gen	neut	sg	suffix /en/
(14)	Adjal		Obl	fem	sg	suffix /er/
(15)	Nounal		dat		pl	suffix /en/
(16)	Nounal				pl	>> GEND:fem, NUM:sg
(17)	noun	wk				>> CAT:adj

Table III. Realization rules.

Each of the rules in Table III provides a realization for certain bundles involving the feature cluster CASE-GEND-NUM. The rules express generalizations by mentioning value clusters (like *Dir* in (2')), including the special case in which a rule mentions the universal set *U* of values for some feature (as when (2') mentions *U* for the feature GEND). Feature clusters can be thought of as ordered *n*-tuples of features -  $\langle \text{CASE, GEND, NUM} \rangle$ , for instance - and the bundles to which a particular rule applies can be thought of as a set of ordered *n*-tuples of feature values, subsumed under a formula for that rule -  $\langle \text{Dir, U, sg} \rangle$  for (2'). A more precise version of (2') would then be

(2'') In the context of [CAT:adj, CLASS:wk],  $\langle \text{Dir, U, sg} \rangle$  in  $\langle \text{CASE, GEND, NUM} \rangle$  is realized by the suffixation of /e/.

In section 14 below I return to the role that feature clusters play in realization rules.

13. *Realization of bases.* There are also, of course, rules of realization for bases, which must be assumed to feed rules of referral and exponence. We can assume that each base has an index distinguishing it from all others, so that a rule of realization for a base can be thought of as a rule of exponence for the index associated with that base.

Suppose that the index of the German definite article *der* is 15, that of the indefinite article *ein* is 16, and that of the demonstrative *dieser* is 17. Then German has rules of exponence like the following:

(19) [INDEX:15] is realized as /d/.

(20) [INDEX:16] is realized as /ayn/.

(21) [INDEX:17] is realized as /di:z/.

Base indices can figure in rules describing exceptional realizations for either bundles or bases. That is, individual bases can condition idiosyncratic realizations for particular inflectional categories (the English noun base *ox*, for instance, conditions the idiosyncratic plural affix *-en*), and individual bases can have idiosyncratic realizations conditioned by particular inflectional categories (the English verb base *say*, for example, has an idiosyncratic realization in the present third singular, and *do* has an idiosyncratic realization in the past).

Some rules of realization for bases describe suppletion. They can be thought of as rules (of exponence or referral) which mention both an index and a bundle. They describe exceptions to rules (of exponence or referral) not mentioning an index, and so override the latter.

According to the rules above, the definite article should have several forms *de*, all based on the nom fem sg, and corresponding to forms like *diese* and *jene*. But in fact these forms are all *die*. Similarly, according to the rules above, the definite article should have a neut nom/acc sg *des*, corresponding to forms like *dieses* and *jenes*. But in fact these forms are *das*, distinct from the masc/neut gen sg *des*, which is the regular product of rule (11). *Die* is an exception to rule (9), *das* to rule (8).

- (22) [INDEX:15, CASE:nom, GEND:fem, NUM:sg] is realized as /di:/.  
(23) [INDEX:15, CASE:nom, GEND:neut, NUM:sg] is realized as /das/.

14. *Slots.* Most languages with inflectional morphology have affixes occurring in several different positions with respect to bases and to one another, and some of these languages also exhibit ordering of morphological processes like reduplication and infixation. I will maintain here - though I don't have the space to defend the assertion - that both linear precedence of inflectional affixes and ordered application of inflectional rules are instances of the same abstract entity, namely the (stipulated, language-particular) ordering of abstract slots for inflectional material.

Returning to the relatively simple situation in German, I can point out at least three reasons for saying that the inflectional suffixes in that language are positioned in slots.

First, there is the fact that the rules of exponence in Table III, all of them referring to the feature cluster CASE-GEND-NUM, describe exponents that are mutually exclusive with one another. These rules of exponence, taken together, fill a single slot (which carries marks of <CASE, GEND, NUM>).

Second, there are the 'indeclinable' nouns of German, exemplified by the neuter *Auto* 'car'. The normal indeclinable noun does not, in fact, lack inflection completely. Instead, it can bear a suffix marking plurality, usually *-s*; the plural of *das Auto* is *die Autos* - though this noun has *den Autos* in the dat pl rather than *den Auton*, *den Autons*, or *den Autosen*. What we want to say about the indeclinable nouns is that they are subject to certain realization rules, namely those realizing [NUM:pl], but are not subject to any of the realization rules in Table III, which realize various bundle triples in <CASE, GEN, NUM>. This can be done by saying that the indeclinables have a slot for NUM but lack one for CASE-GEND-NUM.

Third, there are many declinable nouns for which both the NUM slot and the CASE-GEND-NUM slot can get filled, in the dat pl. For the neuter *Buch*, the NUM slot is filled by suffixation of *-er* with concomitant umlaut of the base: *die Büch-er*. The CASE-GEND-NUM slot is filled by an *-n* alternant of the dat pl suffix *-en* supplied by rule (20): *den Büch-er-n*. Note that the NUM slot is ordered before the CASE-GEND-NUM slot.

Even from this rather uncomplicated situation it should be clear that the feature clusters associated with different slots can overlap. In German, in fact, the feature cluster associated with the first slot (NUM) is a proper part of the feature cluster associated with the second (CASE-GEND-NUM). Quite correctly, I believe, nothing in my proposals would require that a given feature be realized in only one slot, or that a given slot realize only one feature.

15. *Final remarks.* Much more needs to be said about the details of the framework I have been sketching. I have said almost nothing about non-affixal inflectional morphology. The treatment of agreement features must be somewhat more elaborate than I have made out here, to accommodate (for example) instances in which agreement features of subject, direct object, indirect object, and so on must be distinguished (as in Algonquian, Abkhaz, and other languages familiar from the literature) and instances in which inherent features of a constituent must be distinguished

from those it bears by virtue of agreement, as when the inherent features of a possessor NP must be distinguished from the agreement features originating with the possessed NP. The formalization is incomplete and not fully explicit. [6] And I have said nothing whatsoever about a constellation of evidential issues, among them: how to decide whether certain facts call for a rule of referral rather than a rule of exponence; how to choose one rule of exponence over plausible alternatives that cut a paradigm up in different ways; when to assign material to the same slot and when to different slots; and whether such questions can be answered entirely on the basis of a presentation of the paradigms in a language, or whether (as seems virtually certain) some types of 'external evidence' must be appealed to.

Despite all these loose ends, I do hope to have given something of the flavor of the proposals and some reasons for exploring the possibilities of the framework.

#### Notes

- \*The bulk of this paper was written during the summer of 1984 at the Center for the Study of Language and Information, Stanford University; I am indebted to the System Development Foundation for its financial support during this period. The final draft was completed during winter quarter 1985 at the Syntax Research Center, University of California at Santa Cruz; I am indebted to the Ohio State University for its financial support during this period and to UCSC for its hospitality. My thanks to those who encouraged me in this work and to those who gave me their comments and criticisms - especially Rich Janda, Paul Kay, Bill Ladusaw, George Lakoff, Joel Nevis, Geoff Pullum, Jerry Sadock, Ivan Sag, and Hans Uszkoreit.
1. Or in the lexicon, as Jensen and Stong-Jensen (1984) have argued in response to Anderson 1982; this issue is not my concern here.
  2. I do not rule out the possibility that individual rules can also have subrules stipulated as standing in a disjunctive relation to one another. Anderson (1977) proposed such stipulated disjunction for the Algonquian person prefixes on transitive verbs, which have one shape if either subject or object is second person, otherwise another shape if either subject or object is first person, otherwise a third shape. These facts can be described without stipulation - in the formalism developed below, the first shape realizes PERS:2, the second realizes PERS:1/2, and the third realizes any value of PERS - but I am not prepared at the moment to defend either of these analyses over the other.
  3. How is inflection different from (special) cliticization? Since cliticization cannot 'see into' hosts, the only morphophonological operation available for it is affixation (and possibly circumfixation, wrapping material around the base). In the case of inflection, affixation is available, but so is infixation (wrapping the base around material), simulfixation, reduplication, subtraction, consonant gradation, vowel gradation, etc.

How are inflection and cliticization different from word

- formation (derivation and compounding)? Rules for the former are purely realizational, while the rules of word formation involve, in addition to morphophonological operations, principles of semantic interpretation and two types of morphosyntactic conditions: input conditions, on the base(s) to which a rule applies; and output conditions, specifying the category and morphosyntactic features of the word formed by the rule.
4. Williams (1981) seems to have denied this, maintaining that there is only systematic syncretism; but see Joseph and Wallace (1984) for a rebuttal.
  5. I will not treat the traditional strong declension of nouns in this paper. For indeclinable nouns, see section 14. The mixed adjective declension can be treated as a subtype of the weak declension, in which the realization of [CASE:Dir, NUM:sg] is referred to [CLASS:str], although other analyses (not involving referral) could also be defended.
  6. My aim in formalization in this paper is clarity, not completeness or any envisaged computational implementation. Nor do I intend the framework as an incipient processing model (for production or for parsing); I am merely trying to state, in an insightful fashion, what seem to me to be real generalizations about the arrays of inflectional forms in German (and English). The framework lends itself fairly naturally to some of these enterprises, however, and I have no reason to try to dissuade people from exploring it in production terms or (via theorem-proving techniques in a suitable computer language, such as Prolog) as part of a recognition or parsing scheme.

#### References

- Anderson, Stephen R. 1977. On the formal description of inflection. *CLS* 13.15-44.
- Anderson, Stephen R. 1982. Where's morphology? *Ling* 13.4.571-612.
- Bierwisch, Manfred. 1967. Syntactic features in morphology: General problems of so-called pronominal inflection in German. In *Honor Roman Jakobson* 1.239-70. The Hague: Mouton.
- Carstairs, Andrew. 1981. Notes on affixes, clitics, and paradigms. Bloomington IN: IULC.
- Carstairs, Andrew. 1983. Paradigm economy. *JL* 19.115-25.
- Gazdar, Gerald and Geoffrey K. Pullum. 1982. *Generalized Phrase Structure Grammar: A theoretical synopsis*. Bloomington IN: IULC.
- Janda, Richard D. 1983. 'Morphemes' aren't something that grows on trees: Morphology as more the phonology than the syntax of words. In Richardson et al. 1983, 79-95.

- Jensen, John T. and Margaret Stong-Jensen. 1984. Morphology is in the lexicon! *LingI* 15.3.474-98.
- Joseph, Brian D. and Rex E. Wallace. 1984. Lexical relatedness, head of a word and the misanalysis of Latin. *OSU WPL* 29.30-49.
- Karlssoon, Fred. To appear. Paradigms and word forms. In *Papers from the Conference on Natural Morphology, Poznań 1983*.
- Kiparsky, Paul. 1982a. From cyclic phonology to lexical phonology. In van der Hulst and Smith 1982, 131-75.
- Kiparsky, Paul. 1982b. Lexical morphology and phonology. In *Linguistic Society of Korea 1982*, 3-91.
- Linguistic Society of Korea (ed.). 1982. *Linguistics in the morning calm: Selected papers from SICOL-1981*. Seoul: Hanshin.
- Matthews, Peter H. 1965. The inflectional component of a Word-and-Paradigm grammar. *JL* 1.2.139-71.
- Matthews, Peter H. 1972. *Inflectional morphology: A theoretical study based on aspects of Latin verb conjugation*. Cambridge: Cambridge Univ. Press.
- Richardson, John F., Mitchell Marks, and Amy Chukerman (eds.). 1983. *Papers from the parasession on the interplay of phonology, morphology, and syntax*. Chicago: CLS.
- van der Hulst, Harry and Norval Smith (eds.). 1982. *The structure of phonological representations (Part I)*. Dordrecht: Foris.
- Williams, Edwin S. 1981. On the notions 'lexically related' and 'head of a word'. *LingI* 12.2.245-74.
- Wurzel, Wolfgang U. To appear. *Flexionsmorphologie und Natürlichkeit*. *Studia Grammatica*.
- Zwicky, Arnold M. 1977. Hierarchies of person. *CLS* 13.714-33.