STEMS AND PARADIGMS

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This article presents an analysis of the conjugational systems of West Germanic that highlights the central role of two basic stem types and suggests some consequences for the description of inflectional systems in general. The analyses distinguish morphomic stems, which underlie morphosyntactically distinct word forms, from inflectional stems, which realize tense and mood features and provide the input to regular agreement rules. It is argued that the recognition of these stem types simplifies the description of West Germanic conjugations, supports a general realization-based approach, and suggests a reinterpretation of current realizational models.*

1. INTRODUCTION. This article examines some recurrent patterns of stem-based syncretism in West Germanic (WG) and draws a number of general conclusions about the description and analysis of inflectional systems. The first part of the article suggests that the recognition of 'dental' and preterit stems simplifies the description of regular conjugational patterns in WG. The preterit stem in *-e* is an INFLECTIONAL STEM (Matthews 1991) that realizes past tense. The dental stem in *-d/t* is nonmorphemic or MORPHOMIC in the sense of Aronoff 1994, as it underlies a heterogeneous class of forms. The second part of the article argues that the stem-based patterns in WG favor a realization-based approach, since the distribution of the dental stem cannot be described in morphemic terms, and the preterit stem is based in turn on the dental stem. The advantages of a realization-based perspective are, moreover, independent of whether rules are interpreted as devices for 'building' or for 'admitting' word forms.

1.1. CONJUGATIONAL STEMS IN WEST GERMANIC. Table 1 illustrates two salient patterns of stem syncretism in WG conjugational systems, with reference to the forms of the verb 'mow' and its counterparts in Frisian, Dutch, and German.

<table>
<tr><th>LANGUAGE/VERB</th><th>ROOT</th><th>DENTAL STEM</th><th>PERFECT</th><th>PASSIVE</th><th>PRETERIT STEM</th></tr>
<tr><td>English MOW</td><td>mow</td><td colspan="4">mowed</td></tr>
<tr><td>Frisian MEANE</td><td>mean</td><td colspan="3">meand</td><td>meande</td></tr>
<tr><td>Dutch MAAIEN</td><td>maai</td><td>maaid</td><td colspan="2">gemaaid</td><td>maaide</td></tr>
<tr><td>German MÄHEN</td><td>mäh</td><td>mäht</td><td colspan="2">gemäht</td><td>mähte</td></tr>
</table>

TABLE 1. Principal parts of the regular past conjugational series in West Germanic.

The regular forms in Table 1 are all based on a 'dental' stem, which consists of the verb root and a suffixal exponent *-d* or *-t*.[1] These stems are morphomic in the sense of Aronoff 1994, as they make no constant morphosyntactic contribution to the forms that they underlie. In English, the dental stem entirely realizes the regular past series.[2]

*I am grateful to Farrell Ackerman, Martin Durrell, P. H. Matthews, and Andrew Spencer for comments on previous versions, and to the editors Brian Joseph and Gregory Stump and an anonymous referee for highly constructive criticism.

[1] For convenience, forms are mostly represented orthographically, with phonemic analyses given in slash brackets.

[2] Although a number of accounts, including Aronoff 1994, collapse perfect and passive participles in English, the idea that a single stem form realizes the entire 'past' series in English was first suggested to me by Andrew Spencer.

In Frisian, the dental stem realizes perfect and passive participles, while in Dutch and German it does not realize any member of the past series.[3]

In Frisian, Dutch, and German, the dental stem also provides the base for inflectional stems in *-e*, which underlie the preterit paradigms in Table 2. Recognizing inflectional stems in *-e* simplifies the description of the paradigms in Table 2, and identifies the regular agreement markers: 3pl *-en*, 2sg *-st*, and 2pl *-t*, which occur in other finite paradigms. If *-e* is not treated as an exponent of past tense, it cannot be assigned a uniform analysis, as *-e* must function as a tense exponent when it precedes an agreement marker *-en*, *-st*, or *-t*, but as a fusional tense-agreement exponent word-finally.

<table>
<tr><th>LANGUAGE</th><th>PRETERIT STEM</th><th>2PL</th><th>2SG</th><th>PL</th></tr>
<tr><td>English</td><td colspan="4">mowed</td></tr>
<tr><td>Dutch</td><td colspan="3">maaide</td><td>maaiden</td></tr>
<tr><td>Frisian</td><td colspan="2">meande</td><td>meandest</td><td>meanden</td></tr>
<tr><td>German</td><td>mähte</td><td>mähtet</td><td>mähtest</td><td>mähten</td></tr>
</table>

TABLE 2. Regular preterit stem in West Germanic.

1.2. THE MORPHOMIC DENTAL STEM. The concise descriptions in Tables 1 and 2 illustrate the economy achieved by recognizing intermediate stems. Since the preterit stem merely isolates the tense features of preterit forms, it can be described within nearly any model of analysis. For example, the preterit stem can be defined by a realization rule that introduces *-e* as an EXPONENT or MARKER that REALIZES or SPELLS OUT the property [PAST]. Alternatively, *-e* can be assigned to a morpheme such as {PAST} and represented by a separate entry.

The dental stem, in contrast, entirely defies description in morphosyntactic terms, as no constant properties are associated with the exponent *-d/t* in Table 1. Some descriptions, including Halle & Marantz 1993:125, assign preterits and participles the common feature '[+ PAST]'. But this feature does not represent a genuine tense property, given that it is associated with tenseless participles as well as with finite preterits. Hence, the feature [+ PAST]—like their feature [+ PARTICIPLE]—characterizes a 'pure' form class; in this case, the class of forms based on the dental stem.

Because the morph *-d/t* does not signal any constant morphosyntactic property, it cannot be assigned to any morpheme. For the same reason, *-d/t* cannot be introduced as the realization of any substantive morphosyntactic property. Like the supine or 'third' stem in Latin, dental stems in *-d/t* are thus 'parasitic' (Matthews 1972) or morphomic (Aronoff 1994). Moreover, a striking property of dental stems is that they are completely encapsulated within conjugational paradigms.[4] Dental stems do not underlie any forms outside those paradigms and, indeed, there is no evidence that they are associated with

[3] The dental stem is, however, syncretic with the third person singular present indicative form of regular verbs in German.

[4] This encapsulation is characteristic of the principal parts of inflectional paradigms in Germanic generally; even the comparative and superlative adjectival forms that underlie derived verbs such as *better* or *best* in English are arguably derivational (Blevins 2001a). It is nevertheless possible for the principal parts of one inflectional system to underlie formations in another; see Joseph & Smirniotopoulos 1993 for discussion of one such pattern in Modern Greek.

lexical entries, or globally defined lexical stem sets. It is tempting to attribute this restriction to the inflectional character of dental stems. This type of explanation is not possible, however, given that dental stems have no substantive properties other than those associated with uninflected roots. Whereas the inflectional status of preterit stems is reflected in their tense features, the inflectional character of dental stems resides solely in the fact that they underlie inflected forms. But this is precisely the distributional generalization that stands in need of explanation.

Like the principal parts in traditional grammars, dental stems are simply recurrent parts within a series of inflectional forms. Recurrent parts cannot be defined as the realization of a property such as [PAST], because these parts are not associated with any substantive properties other than those associated with the root. They can, however, be described by the OPERATIONS that are invoked by realization rules. In particular, the operations in 1 characterize the form of WG dental stems.

(1) Dental stem operation F_t/F_d
German $F_t(X) = Xt$
English, Frisian, Dutch $F_d(X) = Xd$

Like the 'morphophonological function from verb stems to perfect participles' that Aronoff (1994:24) designates 'F_{en}', the operations F_d and F_t in 1 are pure form-to-form mappings that suffix *d* or *t* to the base *X*. A realization-based model can integrate these operations directly or indirectly. On the first alternative, outlined in §1.3, an approach treats operations as FIRST CLASS OBJECTS and permits distinct realization rules to share the same operation. On the indirect alternative, outlined in §1.4, a SERIES INDEX mediates between substantive properties and operations.

1.3. RECURRENT OPERATIONS. The forms in WG that are built on dental stems can be defined by operations that apply to the dental stems that are defined by the operations in 1. Preterit stem forms are defined in 2 by F_e, which suffixes *e* to a base *X*. Participles are likewise defined by F_{ge}, which prefixes *ge* to *X*.

(2) Preterit and participial operations F_e and F_{ge}
Frisian, Dutch, German $F_e(X) = Xe$
Dutch, German $F_{ge}(X) = geX$

The operations in 1 and 2 do not define stem entries, or an expanded lexical stem set. Pure morphotactic operations of this sort are thus appropriate for describing the pure form classes defined by encapsulated stems. In particular, the syncretism in Table 1 can be captured directly in terms of F_d and F_t, or by applying the operations in 2 to the stems defined by F_d and F_t. This analysis is illustrated in Table 3 for English and German, which together circumscribe the stem-level variation in WG.

FORM	ENGLISH	GERMAN
Preterit stem	$\mathbb{R}$ ([PAST]) = $F_d(X)$	$\mathbb{R}$ ([PAST]) = $F_e(F_t(X))$
Perfect participle	$\mathbb{R}$ ([PERF]) = $Y : F_d(X)$	$\mathbb{R}$ ([PERF]) = $Y : F_{ge}(F_t(X))$
Passive participle	$\mathbb{R}$ ([PASS]) = Y	$\mathbb{R}$ ([PASS]) = Y

TABLE 3. Operation-based realization of regular past series in West Germanic.

Each of the rules in Table 3 refers to the dental stem in 1. The rule that realizes the preterit stem is a RULE OF EXPONENCE of the sort proposed by Zwicky (1985), Anderson (1992), Aronoff (1994), and Stump (2001). The realization relation $\mathbb{R}$ maps a set of properties, just [PAST] in this case, onto the form that spells them out. This spell-out is defined as the dental stem in English, and as the result of applying the preterit operation F_e in 2 to the dental stem in German (as in Frisian and Dutch).

Furthermore, the perfect and passive participle rules in Table 3 share a realization, which is indicated by the variable *Y*. This sharing expresses the fact that perfect and passive participles are identical in form in all WG conjugations, regular or irregular. In English (as in Frisian) the regular spell-out of this shared realization is just the dental stem. In German (and Dutch), this realization is specified as the result of applying the participial function F_{ge} in 2 to the dental stem.[5]

The rules in Table 3 realize each form of the past conjugational series in English by the dental stem. The other WG languages define a preterit stem by suffixing *-e* to the dental stem, while Dutch and German define participles by prefixing *ge-* to this stem. The correspondences in Table 3 hold directly between rules and are not mediated through stem entries or any other unit. Whereas an entry has 'global' scope within a language, the operations $F_d(X)$ and $F_t(X)$ are defined solely within a block of rules that provide a value for *X*. As desired, the dental stem, $F_d(X)$ or $F_t(X)$, is thus encapsulated within a conjugational paradigm, where it is inaccessible to other word formation processes.

1.4. STEM INDEXING. Yet given that dental stems merely preserve the 'inherent' morphosyntactic properties of the root, they can also, in principle, be assigned to an extended LEXICAL STEM SET, in the sense of Anderson (1992:133). For each verb with a root *X*, one defines an indexed dental stem *Xd* (or *Xt* in German), which is selected by members of the past series. A number of accounts develop a notion of STEM INDEXING (Brown 1998), and the detailed treatment of stem alternations in Stump 2001 provides a clear model for this type of analysis. On a particularly straightforward variant of this analysis, stem 'selection' is expressed by having the properties [PAST], [PERF], and [PASS] imply a series index, for example, [DENT]. Then any feature bundle containing [PAST], [PERF], or [PASS] will also contain [DENT]. The series index [DENT] is then spelled out in Table 4 by a rule that invokes the operations in 1.

<table>
<tr><th></th><th>DENTAL STEM</th><th>PRETERIT STEM</th><th>DENTAL 'PAST' PARTICIPLE</th></tr>
<tr><td>English</td><td rowspan="3">ℝ ([DENT]) = $F_d(X)$</td><td>—</td><td rowspan="2">—</td></tr>
<tr><td>Frisian</td><td rowspan="3">ℝ ([PAST]) = $F_e(X)$</td></tr>
<tr><td>Dutch</td><td rowspan="2">ℝ ([DENT PART]) = $F_{ge}(X)$</td></tr>
<tr><td>German</td><td>ℝ ([DENT]) = $F_t(X)$</td></tr>
</table>

TABLE 4. Index-based realization of regular past series in West Germanic.

In German, Frisian, and Dutch, preterit stems are again defined by applying the operation F_e to the dental stem, while regular 'past' participles in Dutch and German are defined by applying the operation F_{ge} to the dental stem. However, the preterit and participial rules in Table 4 need not directly reference the dental stem, as in Table 3. Instead, since the dental stem is defined by a rule, the preterit stem rule and the participial rule can be ordered after the dental stem rule and apply to its output.

The preterit stem rule invokes F_e as the spell-out of [PAST], as in Table 3. Since English has no distinctive preterit stem, it lacks the corresponding rule. One could likewise introduce a pair of cross-referenced rules in Table 4 that spell out the features

[5] Although the regular participial spell-out appears to be specified in the perfect rule, it is shared by both rules. Hence unlike standard RULES OF REFERRAL (Zwicky 1985, Stump 1993b), neither realization is defined in terms of the other.

[PERF] and [PASS], thereby establishing a rule-by-rule correspondence with the rules in Table 3. But the introduction of a series index permits an alternative account of the syncretism between perfect and passive participles that highlights the fact that West Germanic as a whole exhibits no distinctive realization of [PERF] and [PASS]. Both of these properties are realized in WG by 'past' participles, which, in regular verbs, are based on the dental stem. Nearly all feature descriptions of WG associate a feature such as [PART] or [PART +] with perfect and passive participles. Hence on the present account, both participles will be associated with the properties [DENT] and [PART], but differ in that the perfect is associated with [PERF], whereas the passive is associated with [PASS]. Consequently, the syncretism between perfect and passive participles can be captured by spelling out the features that they share in common, that is, [DENT PART], and leaving [PERF] and [PASS] unrealized. Furthermore, this rule needs to be present only in Dutch and German.

In a realization-based model, past participles in English and Frisian will default to the dental stem, since the dental stem rule is the only rule that applies to the feature analyses associated with perfect and passive participles. Preterit stems in English will similarly default to the dental stem, given the lack of a preterit stem rule. These default patterns exploit the general separation between grammatically CONTRASTIVE features and morphotactically DISTINCTIVE forms in realization-based models. The features [PAST], [PERF], and [PASS] are regarded as equally contrastive in each WG language, and yet morphotactically distinctive only in languages that have a rule to spell them out.

1.5. IMPLICATIONS. The operation- and index-based approaches outlined above illustrate different strategies for characterizing morphomic dental stems. By developing different aspects of realization-based models, these alternatives highlight the fundamental trade-off between the complexity of operations invoked by realization rules, and the number and type of features that rules may 'realize'. Since the empirical differences between these alternatives are relatively subtle, and turn on issues that are not fully resolved, the comparison of operation- and index-based strategies is placed in the context of a general overview of alternatives in §4.2. What is of primary importance here is the fact that the rules in Tables 3 and 4 capture the central role that dental stems play in weak conjugations.

It is particularly significant that these weak conjugations represent the default pattern in WG, indicating the productive status of dental stems. The exponent *-d/t* is, in effect, the THEME CONSONANT of regular conjugations in WG, a point that is stressed in sources from Paul (1881:253) to Drosdowski (1995:118). Strikingly, this pattern entirely resists description in morphemic terms. The problem, as noted above, is that *-d/t* has no constant 'meaning' and hence cannot be assigned to any morpheme.

The problems for a morpheme-based account derive ultimately from the fact that conjugational patterns in WG exhibit form classes that are orthogonal to the natural classes defined by substantive morphosyntactic properties. The rules in Tables 3 and 4 indicate how the separation between properties and forms in a realization-based model permits the description of pure form classes. This separation reflects the fact that morphological analysis in realization-based models is not completely subordinated to the task of isolating MINIMAL MEANINGFUL UNITS. Morphosyntactically coherent patterns can, of course, be characterized by sets of exponence rules that spell out a natural class of properties. But rules can also be organized into sets that invoke a common class of operations. These sets of morphotactically coherent rules define form classes of the sort traditionally designated as SERIES.

The descriptions of the past series in Tables 3 and 4 thus illustrate how an exponence-based perspective can integrate insights from other traditions that are inaccessible to morphemic approaches. In particular, the present approach restores a traditional description of WG in terms of 'past' and 'present' participles and, in the case of German, 'past' and 'present' subjunctives. Contemporary sources often object to this nomenclature, on the grounds that 'these terms are potentially misleading' (Quirk et al. 1985:98) or that 'the traditional distinction between ''present'' and ''past'' participle inappropriately suggests a contrast of tense' (Huddleston 1984:84). The obscure status of the feature '[+ PAST]' for Halle and Marantz (1993:125) illustrates the type of confusion that Huddleston (1984) and Quirk and colleagues (1985) have in mind. But as a criticism of the tradition represented by Curme (1935), these objections rest on an anachronistically morphemic interpretation of terms like past and present.

On a morphomic interpretation, the traditional nomenclature provides a coherent and informative classification of forms in terms of their bases. The two conjugational series are organized by their stems, but designated by their finite members. The 'present' series contains indicatives and other forms based directly on the root, whereas the 'past' series contains preterits and other forms based on the dental stem. This notion of a series is lost entirely if forms are designated solely by their exponents, as in the case of '*-ing* forms' (Huddleston 1984:83) or '*-s* forms' (Quirk et al. 1985:98).

It is, again, the basic separation between properties and forms (discussed at length in Beard 1995) that permits a realization-based model to describe form classes. Recurrent operations and morphomic indices merely provide two strategies for mediating between properties and forms. The rules of a realization-based model also need not be interpreted as devices for 'building' words; they can also be construed as constraints that determine the 'admissibility' of forms, or that deduce one form from another. In a realization-based model, one can build either words from stems, or abstract stems from words. Dental stems are significant UNITS OF ANALYSIS, but this does not entail that they are also UNITS OF STORAGE. Moreover, the same is ultimately true of roots. The dissociation of units of analysis from units of storage in a realization-based model is thus fully compatible with a classical word and paradigm conception, in which the lexicon contains fully inflected word forms.

The rules in Tables 3 and 4 are readily interpreted as devices for building preterits and participles from roots, as in the STEM AND PARADIGM models of Zwicky (1985), Anderson (1992), Aronoff (1994), and Stump (2001). On this interpretation, the lexicon is taken to contain, perhaps among other types of items, a set of root entries. Inflectional forms are obtained by substituting a root form for *X*. For example, substituting the German root *mäh* into the German rules in Table 3 or 4 defines a preterit stem *mähte*, and perfect and passive participles *gemäht*, all based on the dental stem *mäht*.

But these rules can also be thought of as constraints that permit the deduction of roots and other forms from any one member of a conjugational paradigm. This interpretation conforms to the classical WORD AND PARADIGM perspective of Saussure (1916) Kuryłowicz (1949), Hockett (1987), and Matthews (1991), in which roots and stems are recurrent parts within a lexicon of whole words. Interpreted in this way, the rules in Tables 3 and 4 express a correspondence between forms, essentially like Wurzel's PARADIGM STRUCTURE CONSTRAINTS (1989). Given an inflected form like *mähte* or *gemäht*, these rules establish *mäh* as the value for *X* and thereby determine the remaining forms.[6]

[6] The difference between a WORD BUILDING and WORD ADMITTING interpretation corresponds to the familiar contrast between a 'rewrite' (Chomsky 1956) and 'node admissibility' (McCawley 1968) interpretation of phrase structure rules.

This offers an interesting perspective on the results of psycholinguistic studies. It is known that regular participles 'prime' their root more strongly than irregular participles, but that irregular participles (Clahsen 1999) and high-frequency regulars (Bybee 1999) both exhibit the word-form frequency effects characteristic of stored forms. It is, to say the least, suggestive that these are just the effects that one would expect on a word and paradigm interpretation of the rules in Tables 3 and 4.

In sum, the stem-based analyses in Tables 3 and 4 characterize a salient nonmorphemic pattern in WG that bears on a number of broader theoretical issues. The proposed realization-based model allows one to reconstruct the traditional notion of form classes and even rehabilitate classical assumptions about the organization of the mental lexicon. I turn now to the task of elaborating these claims and proposals.

2. Stem syncretism in west germanic conjugations. Traditional descriptions of inflectional systems often identify a class of principal parts or stems that supply bases for inflectional rules. In some cases, these stems make a constant morphosyntactic contribution to the words that they underlie. Following Matthews (1991:176), these are designated here as inflectional stems. Not all stems are of this sort, however. Among the stems recognized in descriptive and pedagogical grammars are forms that underlie morphosyntactically distinct words. These pure forms are, following Aronoff (1994), termed morphomic stems. The role of each stem type in WG conjugations is discussed in §2.1. Stem-free descriptions of the same patterns are considered in §2.2, and some implications for morphemic analysis are identified in §2.3.

2.1. Conjugational stems. Morphomic dental stems are described first, since they underlie inflectional preterit stems. Matthews (1972) and Aronoff (1994) show that the supine or 'third' stem in Latin is clearly morphomic, as it underlies the past passive and future active participles solely in form and contributes no properties to these participles.[7] Moreover, once alert to the existence of morphomic bases, one finds that the third stem is by no means an isolated example. It is indeed typical of descriptive and pedagogical grammars to draw attention to formal relations between morphosyntactically distinct elements.[8]

The chart in Table 5 exhibits the morphomic dental stem that underlies the past conjugational series in WG. Like the third stem in Latin, the WG dental stem does not realize any constant tense or mood properties, but is defined solely 'in terms of which forms are built on it' (Aronoff 1994:167).[9]

The regular preterits and participles in Table 5 are based on a dental stem, built from the verb root and a 'dental' stop. The strong preterits and participles, represented in the table by cognates of English 'see', differ from the weak pattern in two general respects: they exhibit medial vowel alternations, and they lack the dental stops that

[7] This claim echoes traditional word-based treatments, such as that of Gildersleeve and Lodge (1895:71) below:

From the Supine stem as obtained by dropping final *-m* of the Supine, form

a. **Perf. Part. Passive** by adding *-s*.

b. **Fut. Part. Active** by adding *-rus* (preceding *u* being lengthened to *ū*).

[8] One can hardly open a traditional grammar without finding cases of this sort. To take just one, Whitney (1889:246) suggests that in Sanskrit 'the active participle-stem may be made mechanically from the 3d pl. indic. by dropping i'.

[9] The Frisian data in Table 5 is from Tiersma 1985, and the Dutch data from Donaldson 1997. Afrikaans is excluded from the table because it has lost both reflexes of the dental stem: a preterit and a participle in *-d/t* (Donaldson 1993).

<table>
<tr><th>LANGUAGE</th><th>CLASS</th><th>VERB</th><th>ROOT</th><th>DENTAL STEM</th><th>PERFECT</th><th>PASSIVE</th><th>PRETERIT</th></tr>
<tr><td>English</td><td>weak</td><td>MOW</td><td>mow</td><td colspan="4">mowed</td></tr>
<tr><td></td><td>strong</td><td>SEE</td><td>see</td><td>—</td><td colspan="2">saw</td><td>seen</td></tr>
<tr><td>Frisian</td><td>weak</td><td>MEANE</td><td>mean</td><td colspan="3">meand</td><td>meande</td></tr>
<tr><td></td><td>strong</td><td>SJEN</td><td>sje</td><td>—</td><td colspan="2">sjoen</td><td>seach</td></tr>
<tr><td>Dutch</td><td>weak</td><td>MAAIEN</td><td>maai</td><td>maaid</td><td colspan="2">gemaaid</td><td>maaide</td></tr>
<tr><td></td><td>strong</td><td>ZIEN</td><td>zie</td><td>—</td><td colspan="2">gezien</td><td>zag</td></tr>
<tr><td>German</td><td>weak</td><td>MÄHEN</td><td>mäh</td><td>mäht</td><td colspan="2">gemäht</td><td>mähte</td></tr>
<tr><td></td><td>strong</td><td>SEHEN</td><td>seh</td><td>—</td><td colspan="2">gesehen</td><td>sah</td></tr>
</table>

TABLE 5. Principal parts of strong and weak verbs.

mark regular conjugations. Strong verbs in English likewise retain a contrast between preterits and participles that has been lost in weak verbs. These distinctive properties of strong verbs both follow on the assumption that strong past forms are not based on a dental stem.

The differences between weak and strong verbs are largely confined to variation in their inventories of principal parts. The preterit paradigms of weak and strong verbs exhibit a uniform structure, as Table 6 illustrates. A comparison of these paradigms shows that they can be organized in strictly ascending complexity. English contains a single preterit form, which simply preserves the dental stem. Frisian, Dutch, and German all form a distinctive preterit base from the dental stem by suffixing *-e*. In all three languages this base functions as the default singular form and underlies a plural in *-n*. The preterit stem also underlies a second person singular form in *-st* in Frisian and German, and a second person plural form in *-t* in German.

The descriptions in Table 6 bring out stem-level convergences in WG that are masked by word-level differences. Weak preterits are always based on the dental stem and are usually formed with *-e*. The sole exception is English, where the preterit is, in effect, a stranded dental stem. The lack of *-e* in strong preterits supports the claim that *-e* is part of the preterit stem, not an agreement inflection.

	AFFIX	ENGLISH		DUTCH		FRISIAN		GERMAN	
Root	—	mow	see	maai	zie	mean	sje	mäh	seh
Dental	-d/t	mowed	—	maaid	—	meand	—	mäht	—
Pret	-e/∅		saw	maaide	zag	meande	seach	mähte	sah
Pl	-en			maaiden	zagen	meanden	seagen	mähten	sahen
2sg	-st					meandest	seachst	mähtest	sahst
2pl	-t							mähtet	saht

TABLE 6. Weak and strong preterit paradigms.

The identification of *-en*, *-st*, and *-t* as pure agreement markers is confirmed by the fact that these elements recur in every inflectional paradigm. The indicative and subjunctive paradigms of SEHEN 'see' in Table 7 illustrate the pattern in German, which retains the most articulated system in WG.[10]

	PRES INDIC		PRES SUBJ		PAST SUBJ	
	SG	PL	SG	PL	SG	PL
1st	sehe	sehen	sehe	sehen	sähe	sähen
2nd	siehst	seht	sehest	sehet	sähest	sähet
3rd	sieht	sehen	sehe	sehen	sähe	sähen

TABLE 7. Strong finite paradigms in German.

The paradigms in Tables 6 and 7 highlight the simple structure of the German conjugational system. There are two regular stem-formation rules, three general agreement rules and two indicative agreement rules. Both stem-formation rules define stems in *-e*. The present subjunctive stem is defined from the root, and the preterit stem is defined from the dental stem. The general agreement rules define forms in *-en*, *-st*, and *-t*. The indicative rules define a first person singular form in *-e*, which is syncretic with the present subjunctive stem and—in weak verbs—a third person singular form in *-t*, which is syncretic with the dental stem. The paradigms in Table 7 also reinforce the morphomic character of the traditional 'past' and 'present' series in WG. Past subjunctive forms are based historically on the preterit stem, while the present series is a 'nonpast' series, whose forms are NOT based on a dental or preterit stem.

More generally, the analyses in this section simplify the description of individual conjugational systems by extracting recurrent patterns that are distributed over inflectional exponents in stem-free alternatives. A comparison of stem-based analyses also isolates the main locus of conjugational variation in WG. The morphomic stems are relatively conservative, and they maintain a striking parallelism. Inflectional stems likewise preserve a common form in the languages that have kept preterit paradigms. It is the agreement systems of these languages that show the greatest divergence, reflecting different rates of inflectional decay or simplification.

2.2. STEM-FREE ALTERNATIVES. It is remarkable that the most stable and conspicuous pattern in the conjugational systems of West Germanic largely defies description within morpheme-based approaches. Given the evident morphosyntactic differences between preterits, perfects, and passives in WG, neither a stem like *mäht* nor the suffix *-t* can be assigned a fixed interpretation. Consequently, morpheme-based accounts cannot treat *mäht* or *-t* as a unitary item, but must distinguish at least two homophonous *-t* affixes. This is illustrated in the descriptions in Table 8, which represent the most widely accepted analyses of WG conjugations. The description of English slightly simplifies Pinker's analysis (1999:36); he proposes 'four lexical entries' for *-d*. The description of Dutch is drawn directly from Booij 2002:57, while the description of German conforms to the analysis in Wunderlich & Fabri 1995:264f.

Affixal homophony is the most striking feature of these analyses. As Table 8 indicates, a stem-free description of WG conjugations must introduce the theme consonant

[10] Both subjunctive paradigms are somewhat marginal in modern German. The present subjunctive is, as Durrell (1996:321) notes, 'much less used in informal registers, and there is much uncertainty among native speakers'. Durrell (1996:325) likewise remarks that the use of the past subjunctive in spoken German 'is restricted to a few common verbs', while Drosdowski (1995:124) characterizes many past subjunctives as 'antiquated' (*altertümlich*) and 'affected' (*geziert*).

	ENGLISH		FRISIAN		DUTCH		GERMAN	
	FORM	AFFIX	FORM	AFFIX	FORM	AFFIX	FORM	AFFIX
Root	walk	—	mean	—	maai	—	mäh	—
Perf part	walked	-d	meand	-d	gemaaid	ge- ... -d	gemäht	ge- ... -t
Pass part	walked	-d	meand	-d	gemaaid	ge- ... -d	gemäht	ge- ... -t
Preterit	walked	-d	meande	-de	maaide	-de	mähte	-te

TABLE 8. WG conjugations.

independently at two, and possibly three, separate points in regular conjugations. The independence of preterit and participial exponents in Table 8 not only obscures an exceptionless syncretism within WG, but also complicates the description of preterit and participial forms. Booij (2002:73), for example, notes that the 'choice between /t/ and /d/' in participles 'is governed by the same principle as the past tense suffix'. Whereas /d/ occurs after a vowel or voiced consonant, as in *maaide* and *gemaaid*, /t/ follows a voiceless consonant, as in *kapte* and *gekapt*, the forms of KAP 'cut'. Booij (2002:57f.) suggests that this pattern cannot be derived from an underlying /də/ on the grounds that 'there is no independently motivated phonological rule of (progressive) voice assimilation'. In particular, a voicing contrast is possible in deverbal nouns such as *gebirgte* 'mountains' or in diminutives such as *schoentje* 'little shoes'. On the assumption that the preterit suffix is *-de/te*, these formations provide a minimal contrast.

Yet if preterits (and participles) are based on a dental stem, such as *maaid* or *kapt*, then the voice assimilation in these cases falls under a broader generalization. Voicing is never contrastive at the end of any domain in Dutch, whether that domain is a syllable, a word, or, in the present case, a stem. Deverbal nouns like *gebirgte* are not based on a dental stem, since the derivational process that defined these forms is, as Booij (2002: 119) notes, no longer productive. The diminutive suffix *-tje* constitutes a syllable, so that there is no syllable- or stem-final *nt* cluster in *schoentje*. In short, the recognition of a dental stem accounts for phonotactic properties of Dutch preterits and participles.[11]

A dental stem also simplifies the morphotactic description of participles in Dutch and German. Given a dental stem in *-d/t*, perfect and passive participles are defined simply by the addition of *ge-*, subject to familiar prosodic conditions.[12] But this option is not available on any stem-free account. Hence, the analyses of Dutch by Booij (2002: 73) and German by Wunderlich and Fabri (1995:265) define participles by introducing a *-d/t* suffix and *ge-* prefix in serial. Some other accounts, including Ackerman & Webelhuth 1998:151, Bauer 1988:20, and Lieber 1992:155, explore the remaining logical possibility, and introduce *ge-* and *-t* in parallel, as the parts of a circumfix *ge . . . t*.

2.3. THE LIMITS OF MORPHEMIC ANALYSIS. A comparison of the stem-based analyses in §2.1 with their stem-free counterparts in §2.2 provides some indication of the descriptive costs incurred by a morphemic analysis of WG conjugational paradigms. The patterns in Dutch and German are of particular importance. If one were to restrict attention to English, it is not obvious what would count as decisive evidence against a morphemic account that was prepared to countenance the affix- and word-level ho-

[11] As Ernestus and Baayen (2003) show, voicing patterns in Dutch are not quite as straightforward as standard descriptions would suggest, but are strongly influenced by similarity to existing forms stored in the mental lexicon of a speaker.

[12] For discussion of these conditions, see Kiparsky 1966, Anderson 1992, Wiese 1996, and Booij 2002.

mophony entailed by a 'one meaning–one affix' principle. How precisely does one establish that preterits and participles are marked by the SAME exponent, and not merely by homophonous suffixes? This question points to a more general concern about morpheme-based descriptions. It is evident that an analyst can usually impose a morpheme-based analysis on a system, but it is much less clear that the description will capture significant patterns of form variation if there are no constraints on the introduction of homophony or morphotactic complications to preserve a meaning-driven analysis.

It is the patterns of recurrent STEM syncretism in Dutch and German that clarify the patterns in WG. As in the case of the supine stem in Latin, it is the fact that this stem underlies multiple forms that confirms its status as a single unit of analysis. A description that fails to recognize this stem thus misses and, indeed, obscures the most basic form generalization in the WG conjugational systems.

One might object that this pattern is merely incidental, but this objection amounts to little more than the observation that it is nonmorphemic. As Paul (1881:253) remarks, the 'dental suffix' (*Dentalsuffix*) has been highly stable in Germanic and constitutes 'the most conspicuous feature' (*das auffälligste Merkmal*) of weak conjugations since Middle High German. Drosdowski (1995:118) likewise identifies this pattern as the marker of the regular conjugation in modern German:

> Die Endungen des Präteritums sind von denen des Präsens eindeutig geschieden, und zwar durch das die Endung erweiternde *t*. Diese *t*-Erweiterung ist das eigentliche Klassenmerkmal der regelmäßigen Verben. Darin und in der Bildung des 2. Partizips . . . unterschieden sie sich von der Hauptgruppe der unregelmäßigen Verben[13]

Can a morpheme-based account integrate dental stems by assigning *-d/t* a form-class meaning such as '[+ PAST]' (Halle & Marantz 1993) or an 'inflection class' or 'stem shape' meaning (Carstairs-McCarthy 1994:741)? Perhaps, but only at the cost of trivializing morphemic analysis beyond recognition. The main substantive claim embodied in the morpheme-based models of Harris 1942 and Hockett 1947 is that the form classes in a language could be described in terms of natural classes of distinctive properties or MEANINGS. Recalcitrant problems with these models led Hockett to revise (Hockett 1954) and ultimately reject (Hockett 1967, 1987) morphemic analysis. The introduction of form and inflection class meanings signals a similar retreat from the original principles of morphemic analysis. Analyses that incorporate these types of meanings are morpheme-based in name only, as they retract any substantive claims about the relation between meanings and forms and retain the term MORPHEME as a descriptive label for any class of morphological elements.

More generally, form-class features cannot provide a general solution to the challenge posed by form classes within any model that apportions the properties of a word to its component morphs. Suppose, for example, that one were to use a feature such as [+ PAST] to characterize (part of) the meaning of the morph *d*. Words of the form *Xd* would then inherit a [+ PAST] value that identifies them as members of the past series. But one is immediately confronted with the problem of explaining how the features of a root *X* combine with those of the *d* affix to determine the distinctive properties of participles and preterits. If one assumes that all of the properties of a word originate on one of its minimal meaningful parts, the features that distinguish participles from preterits must be assigned to either homophonous roots or affixes. Within a morpheme-

[13] 'The preterit endings are clearly distinguished from those of the present, namely through the ending-extending *t*. This *t*-extension is the sole class marker of the regular verbs. In this respect and in the formation of the perfect participle, the weak verbs are distinguished from the main group of the irregular verbs' [JPB].

based model, there seems to be no alternative to recognizing multiple participial and preterit affixes, as in Table 8. Yet given that the members of the past series comprise a form class, they can have no substantive properties in common that imply [+ PAST]. Hence [+ PAST] must be associated individually with participial and preterit affixes, and not with any natural class of affixes. But then using [+ PAST] to 'tag' these affixes serves no real purpose and merely records an identity in form that is exhibited by the morph *d* itself.

The reason that realization-based approaches can make use of morphomic indices is that they permit feature analyses to be 'underdetermined' (Stump 2001:7) by the forms that spell them out. Thus a form index like [DENT] can determine a common realization for the members of a heterogeneous series, whose [PAST], [PERF], and [PASS] properties are not directly spelled out.

3. STEMS, WORDS, AND PARADIGMS. This section shows how a word and paradigm model that incorporates the rules in Tables 9 and 10 (repeated from §§1.3-1.4) can capture the salient patterns of stem syncretism in WG conjugations.

	ENGLISH	GERMAN
Operations	$F_d(X) = Xd$	$F_t(X) = Xt;\ F_e(X) = Xe;\ F_{ge}(X) = geX$
Preterit	$\mathbb{R}$ ([PAST]) $= F_d(X)$	$\mathbb{R}$ ([PAST]) $= F_e(F_t(X))$
Perfect part	$\mathbb{R}$ ([PERF]) $= Y : F_d(X)$	$\mathbb{R}$ ([PERF]) $= Y : F_{ge}(F_t(X))$
Passive part	$\mathbb{R}$ ([PASS]) $= Y$	$\mathbb{R}$ ([PASS]) $= Y$

TABLE 9. Operation-based realization of regular past series.

The rules in Table 9 highlight the morphotactic character of stem variation in WG. The WG languages all retain the same distinctive properties: [PAST], [PERF(ECT)], and [PASS(IVE)], and essentially uniform rule inventories, but differ in the morphotactic resources available for realizing properties. English illustrates the limiting case in which the entire past series is realized by the dental stem. Hence, this series can be defined directly in terms of $F_d(X)$. Frisian invokes F_e to realize [PAST] but again lacks any distinctive realization of participles. Dutch and German invoke F_e to realize [PAST] and F_{ge} to realize [PERF] and [PASS] properties, but do not mark the difference between [PERF] and [PASS].

The operations in Table 9 are the building blocks of a morphotactic analysis, much like the morphological operations in head-driven phrase structure grammar (HPSG, Pollard & Sag 1987:210), the combinatory operations in Montague grammar (Bach 1988:20), or the elementary transformations of early transformational models (Chomsky 1956:121). These operations are independent of the rules in Table 9, and may be invoked to spell out other properties. Yet the dental stem $F_d(X)$ or $F_t(X)$, which is referenced by the rules in Table 9, is assigned a value only within a set of rules that provides a value for *X*. It follows that each of the rules in the table belongs to a common rule BLOCK, in the sense of Anderson 1992 and Stump 2001. The index-based rules in Table 6 are also assigned to a common block in Table 10. This inflectional stem block is preceded by a morphomic stem block, which contains just the dental stem rule.

3.1. THE ORGANIZATION OF REALIZATION RULES. Within the models proposed by Anderson and Stump, rule blocks comprise sets of competing realization rules whose application is regulated by a disjunctive ordering condition. The intuition underlying disjunctive ordering is that more specific rules or constraints preempt more general

	MORPHOMIC STEM BLOCK	INFLECTIONAL STEM BLOCK	
	DENTAL STEM	PRETERIT STEM	DENTAL 'PAST' PARTICIPL
English		—	—
Frisian	$\mathbb{R}([\textsc{dent}]) = F_d(X)$		
Dutch		$\mathbb{R}([\textsc{past}]) = F_e(X)$	
German	$\mathbb{R}([\textsc{dent}]) = F_t(X)$		$\mathbb{R}([\textsc{dent part}]) = F_{ge}(X)$

TABLE 10. Indexed-based realization of regular past series.

ones.[14] For present purposes, a simple definition of relative specificity will do: a rule realizing $\mathbb{R}(\mathscr{F})$ is more specific than a rule realizing $\mathbb{R}(\mathscr{G})$ whenever $\mathscr{G}$ contains a proper subset of the properties in $\mathscr{F}$.[15]

Rules in different blocks must be extrinsically ordered. Anderson's EXTENDED WORD AND PARADIGM model (1986, 1992) organizes rule blocks into a morphological 'assembly line', in which the relative ordering of blocks determines the order in which their rules are applied. Formally, a BLOCK STRUCTURE for a rule set R is then a pair $\langle$B, $\prec\rangle$, where B is a set of blocks that collectively exhaust the rules in R, and $\prec$ is a precedence relation that imposes a linear order on the blocks in B. The relation $\prec$ will also determine a linear order on rules in different blocks if one specifies that a block B precedes another block B' just in case each rule in B precedes each rule in B'.

Approaches that invoke rule blocks also tend to assume that the set B must partition the rule set R into mutually disjoint blocks, which entails that $\prec$ must be a strict order (i.e. rules and blocks do not precede themselves).[16] Yet the assumption that blocks must be disjoint creates difficulties for realization-based treatments of 'portmanteau' patterns (discussed in Stump 1993a) in which rules appear to span multiple blocks. The solution developed in Stump 2001:141f. introduces the notion of a special portmanteau block $[B, B']$, which competes simultaneously with the blocks B and B'.

But portmanteau patterns can also be accommodated simply by relaxing the (unmotivated) requirement that rule blocks must be disjoint. On this alternative, the block structure for a rule set R consists of a pair $\langle$B, $\preceq\rangle$, where B is a set of blocks that exhaust the rules in R, but that need not be disjoint, and $\preceq$ is a weak linear order on the blocks in B (and, again, derivatively on the rules in those blocks). This revision directly admits portmanteau rules that span adjacent blocks. The fact that $\preceq$ imposes a linear order on blocks ensures that any pair of distinct blocks (or distinct rules) is ordered, as before, and guarantees that portmanteau rules do not span nonadjacent blocks.

3.2. ENTRIES AS RULES. Realization rules are simple property-form mappings, and are not usually regarded as augmenting, consuming, or otherwise modifying the proper-

[14] Implicit in any use of disjunctive ordering is the idea that realization rules or constraints are defeasible. The default character of realization rules is stressed particularly by Zwicky (1985) and is a key design principle of the DATR language (Evans & Gazdar 1996) and DATR-based models, such as Network Morphology (Corbett & Fraser 1993).

[15] For more detailed proposals, see Anderson 1986, Anderson 1992:128ff., and Stump 2001:§3. Anderson proposes a heterogeneous group of ordering conditions, which exhibit a 'family resemblance' and assign priority based on rule block membership, whereas Stump defends an alternative in which all block-internal priority is based on relative specificity.

[16] PARADIGM FUNCTION MORPHOLOGY (Stump 2001) assumes that blocks are disjoint, but does not impose a global ordering on blocks, instead allowing paradigm functions to specify the order in which they invoke rules from different blocks.

ties that they spell out.[17] Moreover, realization rules are triggered solely by the PRESENCE of morphosyntactic properties. Hence there is no need to mark preterits as nonparticipial or participles as nonpast in order to prevent the rules in Tables 9 and 10 from 'overapplying'. On a stem and paradigm (SP) interpretation, realization rules apply to a predefined feature bundle and spell out its properties by applying operations successively to a base.

The interpretation of realization rules also depends on the organization of the lexicon. A defining assumption of SP models, like Anderson 1992 and Stump 2001, is that root and stem forms are associated with lexical entries. Most accounts also adopt a separate representational format for rules and entries. However, lexical entries are, in effect, merely a degenerate case of a CONSTANT exponence relation, as Kiparsky (1982) notes in a somewhat different context. Hence the stem entry for the lexeme MOW can be expressed in the same format as the rules in Tables 9 and 10. The entry rule in 3 identifies the form *mow* as the realization of the property [VERB] and the lexeme index [MOW], which, following Matthews (1991:26), is represented by the citation form of the lexeme.

(3) $\mathbb{R}$([MOW, VERB]) = *mow*

A unified format for rules and entries achieves a degree of formal and even conceptual clarity within an SP approach and, in particular, eliminates the need for a separate lexical 'lookup' operation to initiate morphological derivations.[18] This is illustrated by the derivation of the past series in Table 11.

An operation-based analysis of the English past series begins by specifying the property bundles that define distinctive preterit and participial entries.[19] The bundles that represent the past series for MOW in Table 11 share the common category feature [VERB] and the common lexeme index [MOW], and they are distinguished by the tense/aspect properties [PAST], [PERF], and [PASS]. The derivation of forms in Table 11 proceeds by first applying the 'root' entry rule in 3 to define an initial form. This provides a value for *X* in the inflectional rules in Table 9, which in each case simply define the dental stem *mowed*.

	[MOW, VERB, PAST]	[MOW, VERB, PERF]	[MOW, VERB, PASS]
Root Block	mow	mow	mow
Stem Block	mowed	mowed	mowed

TABLE 11. Operation-based realization of regular past series in English.

An index-based analysis differs in that it associates the features [DENT] and [PART] with the feature bundles in Table 12 and introduces a dental stem rule to spell [DENT]

[17] It is precisely this 'non-resource-based' character that allows realization-based models to accommodate the various types of non-biunique 'types of exponence' described in Matthews 1972 and Matthews 1991: 179ff.

[18] The PARADIGM FUNCTIONS in Stump 2001 also avoid the need for lexical lookup. A function *PF* applies to a pair ⟨ρ, σ⟩, consisting of a property bundle σ and ρ, the root form of a lexeme λ. *PF* defines the form of λ that realizes σ by applying realization rules in sequence to ρ. The root form ρ that initiates a derivation is thus given at the outset.

[19] In a paradigm-based model, such as Matthews 1972 or Stump 2001, these bundles correspond to the cells of an inflectional paradigm, though they can also be associated with syntactic preterminals, as Anderson 1992 proposes.

out. On this alternative, all of the forms in Table 12 are realized by the dental stem rule, since English contains no preterit or participial rules.

	[MOW, VERB, DENT, PAST]	[MOW, VERB, DENT, PART, PERF]	[MOW, VERB, DENT, PART, PASS]
Root Block	mow	mow	mow
Stem Block	mowed	mowed	mowed

TABLE 12. Index-based realization of regular past series in English.

The contrast between Tables 11 and 12 indicates how an operation-based analysis minimizes features, at the cost of expanding the rule inventory, whereas an index-based analysis uses fewer rules, at the cost of extending the class of features. Although these analyses are largely intertranslatable, an index-based analysis provides a somewhat more transparent description of Frisian, Dutch, and German because it separates the dental stem rule from the subsequent preterit and participial rules. To exploit this transparency, the following analyses are stated in terms of the index-based rules in Table 10, though it should be borne in mind that the same patterns could also be described by means of the rules in Table 9.

On either type of analysis, the variation in strong conjugations will reflect patterns of preterit and participial suppletion. A strong verb like SEE will again have the basic stem entry in 4.

(4) $\mathbb{R}$([SEE, VERB]) = *see*

The suppletive preterit entry in 5a must also be listed, along with the participial entry in 5b.

(5) a. $\mathbb{R}$([SEE, VERB, DENT, PAST]) = *saw*
b. $\mathbb{R}$([SEE, VERB, DENT, PART]) = *seen*

Stating the entries in 5 as rules allows a standard disjunctive ordering condition to assign these entries priority over the less specific stem entry in 4. Indeed, the original motivation suggested by Kiparsky (1982) for coercing entries into rules is precisely that this permits interactions between stem and word forms, notably suppletive forms, to be regulated by the same conditions that apply to rules. Anderson (1992:182) summarizes Kiparsky's proposal in the following terms: 'We might actually achieve a kind of typological uniformity within the lexicon by thinking of individual stipulated items . . . as constituting a kind of especially specific ''rule'', though we take no stand here on the content or desirability of that move'.

The realization of strong forms in Table 13 is thus entirely determined by the suppletive entries in 5, since each entry is more specific than either root entry in 4 or the rules in Table 10 (or Table 9). More precisely, the stem entry in 4 is overridden, as

	[SEE, VERB, DENT, PAST]	[SEE, VERB, DENT, PART, PERF]	[SEE, VERB, DENT, PART, PASS]
Root Block / Stem Block	{saw	{seen	{seen

TABLE 13. Realization of strong past series in English.

are the regular exponence relations in Table 10. The overrides in Table 13 reflect the fact that a rule introducing a suppletive word form must span the rule blocks of an inflectional system, since the suppletive form is not subject to further modification. If, as suggested in §3.1, blocks may share rules, then a suppletive entry rule like 5a is just a portmanteau rule that spans all of the blocks of a system.[20] There is no need to assign explicit priority to suppletive portmanteau rules. These rules are distinguished solely by the fact that they occur in multiple blocks; within any block they are subject to applicable disjunctive ordering conditions.

3.3. A STEM AND PARADIGM ANALYSIS OF WEST GERMANIC CONJUGATIONS. The analysis applied to English in §§3.1 and 3.2 extends directly to the other WG languages. This analysis will again be stated in terms of the index-based rules in Table 10, though one could equally well apply the operation-based rules in Table 9 to these patterns. An analysis of representative regular and irregular German verbs is given in Table 14. For the sake of brevity, these analyses suppress the feature [VERB] and identify the morphomic and inflectional stem blocks as M-Stem and I-Stem.

	[MÄHEN DENT PAST]	[MÄHEN DENT PART PERF]	[MÄHEN DENT PART PASS]	[SEHEN DENT PAST]	[SEHEN DENT PART PERF]	[SEHEN DENT PART PASS]
Root	mäh	mäh	mäh			
M-Stem	mäht	mäht	mäht	sah	gesehen	gesehen
I-Stem	mähte	gemäht	gemäht			

TABLE 14. Realization of strong and weak past series in German.

The forms of the regular verb MÄHEN are defined by applying the dental stem rule to the root *mäh* to obtain *mäht* and then applying the preterit and participial rules in Table 10 to obtain the forms *mähte* and *gemäht*. The suppletive preterit and participial entries associated with the strong verb SEHEN preempt entirely the application of the basic stem entry and regular rules in Table 10. There is nothing to be gained by listing each of these entries, as they have the same category and tense/aspect properties as their counterparts in 4 and 5, and merely have different forms and lexeme indices.

The Dutch counterparts in Table 15 exhibit a similar structure, with different patterns of suppletion. The corresponding Frisian series in Table 16 are again similar in structure

	[MAAIEN DENT PAST]	[MAAIEN DENT PART PERF]	[MAAIEN DENT PART PASS]	[ZIEN DENT PAST]	[ZIEN DENT PART PERF]	[ZIEN DENT PART PASS]
Root	maai	maai	maai			
M-Stem	maaid	maaid	maaid	zag	gezien	gezien
I-Stem	maaide	gemaaid	gemaaid			

TABLE 15. Realization of strong and weak past series in Dutch.

[20] Assigning the suppletive rules in 5 to a [Root, Stem] portmanteau block (along the lines suggested in Stump 2001:141f.) would also allow them to take priority over the Root block rule in Table 13 and the Stem block rules in Table 9.

to Tables 14 and 15. However, participial forms are morphotactically simpler in Frisian, due to the loss of the prefix *ge-*.

	[MEANE DENT PAST]	[MEANE DENT PART PERF]	[MEANE DENT PART PASS]	[ZIEN DENT PAST]	[ZIEN DENT PART PERF]	[ZIEN DENT PART PASS]
Entry Block	mean	mean	mean	{seach	{sjoen	{sjoen
Stem Block	meande	meand	meand			

TABLE 16. Realization of strong and weak past series in Frisian.

The preterit stems in Tables 14–16 provide a base for preterit paradigms in German, Dutch, and Frisian. In particular, the German preterit stem provides a base for the agreement rules in Table 17.

FORM	RULES	OPERATIONS
PL	$\mathbb{R}([\text{PL}]) = F_{en}(X)$	$F_{en}(X) = Xen$
2PL	$\mathbb{R}([2\ \text{PL}]) = F_t(X)$	$F_t(X) = Xt$
2SG	$\mathbb{R}([2\ \text{SG}]) = F_{st}(X)$	$F_{st}(X) = Xst$

TABLE 17. General agreement rules in German.

The morphotactic structure of preterits and other finite forms is expressed by organizing the rules in Table 17 into a separate block that follows the blocks of stem rules in Table 10 (or Table 9). The effect of these rules again depends in part on some more general assumptions about the structure of conjugational paradigms. If one assumes that each contrastive person/number combination defines a separate cell, the three person features and two number features in German will determine the six cells in Table 18.

	[MÄHEN DENT PAST 1 SG]	[MÄHEN DENT PAST 2 SG]	[MÄHEN DENT PAST 3 SG]	[MÄHEN DENT PAST 1 PL]	[MÄHEN DENT PAST 2 PL]	[MÄHEN DENT PAST 3 PL]
Root	mäh	mäh	mäh	mäh	mäh	mäh
M-Stem	mäht	mäht	mäht	mäht	mäht	mäht
I-Stem	mähte	mähte	mähte	mähte	mähte	mähte
Agr	mähte	mähtest	mähte	mähten	mähtet	mähten

TABLE 18. Fully specified paradigm in German.

Relative specificity governs the application of the rules in Table 17 to the property bundles in Table 18. The 2pl rule spells out the 2pl cell by adding *-t* to the preterit stem; the less specific plural rule spells out the remaining plural cells by adding *-en*. The 2sg rule likewise spells out the 2sg cell by adding *-st*; the remaining singular cells are just realized by the preterit stem. The general syncretism between first and third person in Table 18 again illustrates what Stump terms ‘underdetermination’ (2001:7). If one assumes the paradigm structure in Table 18, the difference between first and third person is contrastive at the level of paradigm cells, but German merely lacks a rule to spell out this contrast formally.

The rules in Table 17 are equally compatible with other assumptions about paradigm structure. A number of accounts, including Andrews 1990, Wunderlich & Fabri 1995, and Blevins 2000 recognize only as many cells as there are distinctive forms in a paradigm. On the assumption that form variation determines paradigm structure, the preterit paradigm would have the four cells in Table 19.

	[MÄHEN DENT PAST SG]	[MÄHEN DENT PAST 2 SG]	[MÄHEN DENT PAST PL]	[MÄHEN DENT PAST 2 PL]
Root	mäh	mäh	mäh	mäh
M-Stem	mäht	mäht	mäht	mäht
I-Stem	mähte	mähte	mähte	mähte
Agr	mähte	mähtest	mähten	mähtet

TABLE 19. Underspecified paradigm in German.

Relative specificity again regulates the application of the rules in Table 17. The 2sg and 2pl rules spell out the corresponding 2sg and 2pl cells. The plural rule spells out the other plural cell, irrespective of whether the cell is specified simply as 'plural', as in Table 19, or as 'plural' and 'non-2nd'. There is no rule to spell out the person-neutral singular cell, so it defaults once again to the preterit stem.

Preterit paradigms in Dutch and Frisian present an analogous choice between maximally and minimally specified paradigms. The Dutch forms in Table 6 are perhaps most naturally assigned to paradigms with just singular and plural cells, given that there is no contrastive person marking. Since the Frisian paradigms in Table 6 contain a 2pl form, they require at least three cells, though one could recognize six cells, as in Table 18, and attribute their overlap to the lack of applicable spell-out rules.

3.4. THE STATUS OF STEMS. These brief analyses of English and German bring out the intuitive appeal of a realization-based analysis of West Germanic conjugations. The dental stems defined by the rules in Table 10 (and Table 9) directly capture the morphomic syncretism that underlies these conjugations. The introduction of preterit stems eliminates the need for the ZERO MORPHS that represent unrealized properties in ITEM AND ARRANGEMENT models. Furthermore, unlike ITEM AND PROCESS models, there is no need to introduce a rule for every unrealized property. This follows from the fact that a realization-based model defines the structure of paradigms independently of the rule system, typically by general constraints on feature cooccurrence. Hence a property may be contrastive within a system and yet have no formal realization; a possibility that is excluded in models that begin with underspecified stem entries and add morphosyntactic properties in parallel with the attachment of affixes or the application of rules.[21]

Dental and preterit stems illustrate the value of this distinction. On nearly any assumptions about the structure of conjugational paradigms in German, the preterit stem will realize contrastive number and possibly person features that are underdetermined by the forms and rules of the language. A comparison of English with the other WG languages likewise suggests not only that English does not contain multiple inflectional '*d*' exponents, but that it in fact contains NONE. Regular English forms in *-d* are just stems, stranded by the collapse of the inflectional system. The ISOLATING or WORD-BASED character of English is reflected in the fact that dental stems and irregular forms are not subject to further modification. The irregular conjugations described by Quirk

[21] Stump (2001:2) classifies these models as 'incremental', on the grounds that affixes or rules 'increment' properties.

and colleagues (1985:114ff.) then simply reflect different patterns of word-level preterit and participial suppletion.

The analyses in §3.3, however, also hint at some of the less attractive aspects of realization-based accounts. Controlling the interactions between types of rules and entries tends to be a major preoccupation of the best-developed accounts, such as those of Anderson 1992 and Stump 2001. In fact, any specificity-based notion of rule priority quickly requires elaborations, often of a fairly technical nature. Anderson (1992:132) extends disjunctive ordering to give rules in earlier blocks priority over rules in later blocks. Stump (2001:72) likewise proposes different 'modes of application' for realization rules, introducing an 'expanded mode' that takes priority over unexpanded rules.

From a classical word and paradigm perspective, the complexity that arises in controlling rule application within a realization-based approach reflects the intermediate character of these approaches. As the designation STEM AND PARADIGM (SP) is meant to suggest, these approaches are poised between morpheme-based and word-based models. Like a classical word and paradigm (WP) model, SP approaches associate morphosyntactic properties with words, not with their constituent morphs. Yet, like morpheme-based models, SP approaches represent lexical items by subword units, namely roots (and possibly other stems as well). As minimal units that signal the inherent properties of a given lexeme, roots are, in essence, a type of residual morpheme. There are, to be sure, important differences between the way that roots are treated in SP and morpheme-based models. But the very idea of representing lexemes by MINIMAL RECURRENT ELEMENTS is oddly incongruous with a realization-based approach and leads to an inconsistent treatment of lexical and grammatical subword units.

The notion of 'deriving' the forms of a paradigm from a common base likewise reflects a root-based point of departure. In Germanic, as in many languages and language families, roots have very few positive properties and are of limited predictive value. Their role is largely confined to providing a base for derivational and inflectional processes. If one restricts attention to the weak patterns described by the rules in Table 9, it is not implausible to propose, as Anderson (1992:134) does, that 'an item's paradigm is the complete set of surface word forms that can be projected from the members of its stem set by means of the inflectional . . . [r]ules of the language'.

But a derivational perspective leads to an uncomfortable choice in the analysis of strong conjugations. If the forms of a paradigm are derived from a common stem or stem set, what stem set underlies strong patterns, and what sorts of rules project these stems onto surface forms? There are no regular phonological processes in Germanic that can be invoked to derive the surviving ablaut patterns. A derivational account must either treat these patterns as entirely suppletive, or else introduce morphologically restricted rules. The 'minor rules' proposed in the analysis of English by Halle and Marantz (1993:128) underscore the problematic nature of such rules, which often describe no more than a few forms, using structural descriptions that simply list individual lexemes.

3.5. A WORD AND PARADIGM APPROACH TO WEST GERMANIC CONJUGATIONS. From a WP perspective, the anomalous status of roots in a realization-based model and the difficulties that arise in deriving strong patterns from roots can both be traced to the assumption that the lexicon contains stem entries, such as those in Table 11 and example 4. From a classical WP standpoint, words are not only the locus of realization relations; they are also the basic unit of lexical storage. Stems and roots may function as significant units of analysis, but they are derivative, abstracted from inventories of full forms. Anderson (1992:369) provides a lucid statement of this alternative conception.

> Thus, the stem of a paradigm is founded on the various fully inflected forms, rather than *vice versa*. Kuryłowicz regards the grammar as a set of relations among full surface forms (much as Saussure did: see Anderson 1985), rather than a set of rules specifying the construction of complex forms from simple constituents. In fact, the difficulties that arise in views of morphology based strictly on morphemes construed as minimal signs . . . suggest that this picture may merit more consideration than it has sometimes received.

The fact that roots often lack positive properties is explicable if a root is merely what remains when one abstracts away from the exponents that distinguish the inflected forms of a paradigm. In a regular paradigm, there may be a constant base shared by all forms. But then again, there is no reason to expect that there will always be such a base. Inflectional paradigms may make systematic use of multiple bases, as Estonian clearly does (Hughes & Ackerman 2002, Blevins 2003). Or, as in the case of the strong verbs in Germanic, bases may exhibit patterns of interpredictability that cannot be assimilated to any regular phonological process. This type of variation is not problematic for classical WP models, in which the shift from a stem-based to word-based orientation is accompanied by a focus on PREDICTING one form from another, rather than on DERIVING one from the other.[22]

Although it is implausible to derive strong forms from the root synchronically in any WG language, the surviving forms fall into a number of recognizable ablaut series, especially in German, the most conservative language. Drosdowski (1995:124–25) reports that 'in total there are around 170 ablauting verbs, divided into 39 ablaut series' (*Insgesamt gibt es rund 170 ablautende Verben, die sich auf 39 Ablautreihen verteilen*) of which some 15 are 'represented by only a single verb' (*nur durch ein einziges Verb vertreten*). It would be implausible to claim that speakers are unaware of these patterns, and Clahsen et al. 1997 shows that speakers do extend ablaut patterns to rhyming nonce verbs.

Within a WP model, these series reflect patterns that are resident in a finite—in fact, quite small—number of high-frequency forms. In the most populous series, a present form and the preterit stem are reasonable predictors of the strong participle. Thus the forms *singe* and *sang* of SINGEN 'sing' predict *gesungen*, while the forms *bleibe* and *blieb* of BLEIBEN 'stay' predict *geblieben*. The fact that the individual forms are listed does not mean that form generalizations are thereby 'missed' or that the patterns that they exhibit are thereby somehow obscured for the speaker. It is merely that these patterns have not been encapsulated in a separate system of rules, templates, or schemas.

The reason for this is that any representative of an ablaut series provides a model for extension, in the same way that exemplary paradigms provide a pattern for inflectional patterns in general. The pedagogical usefulness of exemplary paradigms is, as Matthews (1991:9f.) remarks, well established:

> Pupils begin by memorising PARADIGMS. These are sets of WORDS AS WHOLES, arranged according to grammatical categories . . . This is not only traditional, it is also effective. It seems unlikely that, if a structuralist method or a method derived from structuralism were employed instead, pupils learning Ancient Greek or Latin—or, for that matter, Russian, Modern Greek or Italian—would be served nearly so well.

A WP model assumes that memorized patterns provide a useful basis for analogical extension IN GENERAL, and that pedagogical practices merely exploit this fact. This

[22] The relation between WP and SP is thus analogous to the relation between the 'transformations' of Harris 1957 and those of Chomsky 1956. Whereas Harris's equivalence relations represent the interpredictability of expressions in a corpus, the more familiar transformations proposed by Chomsky are devices for constructing representations.

position reflects a rejection of the strict division between data and program, which is expressed by the familiar dichotomy between 'entries and rules' (Pinker 1999). Instead, forms such as *singe*, *sang*, and *gesungen* may serve a dual function. These forms function as 'data', in that they represent the first person singular present, the preterit stem, and the participial forms of a particular verb, namely SINGEN. Yet they also serve as 'program' by providing an analogical base for the inflection of other verbs whose present stems rhyme with *sing*.

Furthermore, a WP approach can provide a more flexible treatment of strong patterns while preserving the analysis of each of the regular patterns in §3.3. In effect, the shift to a word-based perspective just reverses the direction of the realization relations expressed by the rules in Tables 10 and 17. Rather than interpreting these rules as devices for constructing the word forms at the bottom of Table 18 from the stems at the top, a WP approach construes them as patterns that deduce the stems at the top from the word forms at the bottom. Given the fully inflected word form *mähtest*, the 2sg rule identifies *-st* as the agreement marker and *mähte* as the preterit stem. The preterit rule in Table 10 in turn identifies *-e* as the preterit exponent, *mäht* as the dental stem, and *mäh* as the ultimate stem, or root. The analyses of each of the other weak forms are similarly reversible.

The reversibility of regular formations reflects the fact that any simple set of realization rules can be interpreted as devices for either building or admitting words. The blocks into which rules are organized do not impinge on bidirectionality. Blocks demarcate morphotactic domains, irrespective of whether elements are added in those domains to build words, or abstracted away to deduce stems. The bidirectionality of realization rules makes them equally compatible with models of generation or comprehension. The word-building orientation of SP models is compatible with a generation-based perspective, in which realization rules interpret a property set and determine an output form. On a word admissibility interpretation, rules are applied to a form to deduce property bundles.[23]

Moreover, an approach that proceeds in general from word forms to stems does not face a problem of 'preempting' regular alternatives to suppletive entries. Speakers clearly cannot use the rules in Table 10 (or Table 9) to recover the root form of SEE from the suppletive preterit *saw*. They will be able to obtain the stem *see* from other regular forms. Hence, they will be able to produce a regular preterit for SEE and other strong verbs. Yet in a lexicon containing *saw,* there is no motivation for innovating a regular form. New forms will be added to a word-based lexicon if they are encountered or formed often enough. Low-frequency formations will tend to be produced as needed. But there is no reason in a WP model to assume that forms are blindly constructed by an autonomous rule system.

There are two more general consequences of the shift from derivation to prediction in a WP model. The first is that productivity may be regarded as a graded phenomenon.[24] The inflection of a new item can be modeled as a process of matching a basic form

[23] The fact that property bundles may be underdetermined by the forms that realize them will impact on these processing tasks in different ways. Underdetermination raises no difficulties for a production task, since the underdetermined properties are, in effect, given. A comprehension task can likewise exploit the fact that the wellformed bundles are defined independently of the rule system and postulate the most highly specified feature bundles compatible with a given form.

[24] Analogical models (see, for example, Skousen 1989, 1992, Ernestus & Baayen 2003, and Wedel 2004) offer an interesting perspective on the pattern-matching implied in a graded notion of productivity based on a closest match.

of the item against the existing patterns in the language to find the closest match. If the present stem of an item rhymes with the present stem of an ablaut series, the remaining members of that series provide a model for the inflection of the new item. In a language with a robust system of inflectional classes, there may be a number of different patterns, all productive but imposing different matching requirements. If the new item does not conform to any of these, it may follow the regular pattern, or perhaps be assigned to a class of indeclinable elements. But the main point is that the use of prediction rather than derivation admits a range of alternatives between fully productive defaults and nonproductive suppletion.

The second consequence is that notions like defeasibility are particularly natural within a model based on pattern matching. If the inflection of an item involves matching it to the closest pattern in a language, then DISJUNCTIVE ORDERING is ultimately a property of the search process, in which more specific patterns must be checked first or else the default will always apply. This reformulation in itself provides no additional insight. However, it does sidestep a class of concerns about undergeneralization and morphological blocking. A derivation-based description of a morphological system can give the impression that productive processes are not applying everywhere that they could, and that existing formations are responsible for inhibiting their application. This observation provides the point of departure for the influential discussion of morphological blocking in Aronoff 1976.

Yet from a WP perspective, the problem addressed by blocking conditions is purely an artifact of a derivational conception. Established words that are in general circulation within a speech community will tend to obviate the need for new formations with a similar interpretation. Where there are lexical gaps of one sort or another, productive strategies will often be used to fill them. But asking why a given affix does not combine with every possible root in a language is rather like asking why every well-formed monosyllablic or bisyllabic form does not have a meaning. Certain possible words of English are not actual words of English because they have not been used with the frequency and consistency required to establish them within any English-speaking speech community. One common reason for this is that a perfectly suitable term is already in general use. The causal connection is not mysterious, but it is surely not appropriate to regard this as a matter of grammar.[25]

4. EXTENSIONS AND IMPLICATIONS. The preceding sections highlight descriptive benefits of recognizing morphomic and inflectional stems in analyses of WG conjugations. To a considerable extent, these descriptions merely formalize a type of analysis that is assumed in traditional and pedagogical sources. Although pedagogical materials are rarely taken seriously in theoretical discussions, it may be appropriate to reconsider this prejudice. One cannot help but be struck by the fact that the vast majority of grammatical traditions associated with morphologically complex languages are word based.[26] Virtually all lexicographical materials are word based; one does not in general find root-based dictionaries, much less entries for inflections. Even in languages that exhibit systematic and transparent patterns of stem syncretism, such as Estonian (Erelt et al. 2000), the native grammatical tradition remains firmly word based.

[25] I owe this general point to public remarks made by P. H. Matthews at a meeting of the Philological Society in 2000.

[26] The Sanskrit grammarians constitute the principal exception, and it is perhaps no accident that this tradition is the best known to contemporary theoreticians. See Cardona 1976 for a summary of research.

Morphomic stems correspond to the rules of thumb that traditional grammars use to define one form in terms of another, previously defined, form. In theoretical studies, these stems are almost completely unattested outside of realization-based accounts, because they cannot be straightforwardly derived by the procedures of segmentation and classification that still underlie contemporary morpheme-based models. The recognition of nonmorphemic formatives is a defining characteristic of realization-based approaches, reflecting their rejection of the biunique relation between features and exponents encapsulated in the structuralist 'morpheme'. The case for morphomic exponents tends to be strongest in relatively complex inflectional systems, such as those of Latin (Matthews 1972, Aronoff 1994), Georgian, or Potawatomi (Anderson 1992, Stump 2001). This typological bias has suggested to some scholars, notably Matthews (1972), that realization-based approaches may be uniquely suited to the description of fusional languages but no more or less suitable as a general model of morphological analysis than morpheme-based accounts. However, the present account suggests that this typological qualification applies at most to morphomic affixes; the benefits of recognizing morphomic STEMS are evident even in comparatively simple inflectional systems. The simple conjugational systems of English, Frisian, Dutch, and German illustrate this point. These languages are only nominally inflecting, and they indicate the low FUSIONAL THRESHOLD at which a realization-based approach enjoys descriptive advantages over morpheme-based models.

4.1. DIACHRONIC RESIDUE. Remarkably, although there is no obvious theoretical antecedent for defining productive weak forms from dental stems, there is a long tradition of deriving the nonproductive strong ablaut patterns. In principle, a WP model could extract the generalizations exhibited by strong verbs and declare them in templates of the sort proposed by Wunderlich & Fabri (1995). But it is not obvious what would be achieved by this schematization. Nearly half of the ablaut series have a single representative, only a third have more than three, and exactly seven series have more than a half-dozen basic verbs. So in the great majority of series, the schematization of vowel alternations would achieve no economy. Indeed, the use of 'non-monotonic inheritance trees' to describe these patterns in Wunderlich & Fabri 1995:255 provides a fairly clear indication that the resulting descriptions serve mainly to catalogue patterns of variation within a lexical inventory of full forms.

One could question whether a strong participle like *gesungen* might not be derived by prefixing *ge-* and/or suffixing *-en* to a stem form. The problem with this proposal is that a stem such as *sung(en)* would serve no purpose other than to feed the rule of *ge-* prefixation. Listing a participial stem that is used exactly once in the grammar again achieves no economy over listing the full participle.

One might still object that listing strong participles misses generalizations about their form, but this type of objection rests ultimately on two highly questionable assumptions. The first, as noted above, is the belief in a strict separation between data and program. There is no principled reason to assume that a generalization that is true of a set of forms must be expressed independently of those forms or else the generalization will be missed and the pattern reduced to an accidental characteristic. The fact that speakers recognize and even extend a pattern does not entail that they must therefore represent that pattern separately from the forms that instantiate it.

The second assumption reflects the overwhelmingly synchronic emphasis of most contemporary theoretical work. As the residue of a once-general process, strong forms in Germanic naturally exhibit residual similarities, both to other members of their ablaut series and to other strong formations. There is no reason, however, to suppose that any part of the synchronic system is responsible for actively enforcing these similarities. Rather, established strong forms will maintain their form until they are discarded or regularized, typically when they fall below a certain frequency threshold.

The key empirical issue, however, is not whether linguists can mine generalizations out of strong patterns. It is whether there is any evidence that speakers internalize these patterns by decomposing strong forms and representing the generalizations that they exhibit independently. As far as one can tell, all of the available psycholinguistic evidence suggests that strong preterits and participles in WG are in fact listed as unanalyzed wholes. Clahsen (1999:1001) notes that regular participles in *-t* 'exhibit full priming effects' on their roots, whereas strong participles in *-en* exhibit 'only partial priming'. Conversely, in lexical decision tasks, Clahsen (1999:999) reports 'word-form frequency effects for participles of different subclasses of strong verbs but not for *-t* participles of weak verbs'.

Speakers clearly treat strong forms as forms of the same verb. But this relation does not implicate a decomposed representation of strong forms and does not appear to be mediated through the root form of a lexeme. Hence, the relation can be expressed just as well by a lexeme index, or, for that matter, by storing strong forms, as wholes, within a network of connected or contiguous entries.

The body of results summarized by Clahsen (1999) strongly suggests that the inflection classes sometimes attributed to WG (and Germanic generally) are essentially taxonomic artifacts. The conjugational systems of these languages contain regular formations, along with finite inventories of full words whose form reflects a variety of historical processes. It is certainly possible to group these residual forms into classes for comparative or pedagogical purposes, and even to extract recurrent patterns within classes. However, there is no evidence that speakers decompose strong verb forms into stems and exponents, nor that they use strong patterns with any regularity as the basis for inflecting new verbs.

It is the simplicity of WG inflectional systems that permits an essentially binary distinction between regular and suppletive patterns. In more complex inflectional systems, productive patterns can often be organized into distinct inflection classes, which apply to items with characteristic forms and/or properties. The present account is deliberately agnostic regarding the treatment of inflection classes. Within a WP model, however, there is no need to introduce inflection class 'features' to represent the class of a lexeme, since the form and/or properties suffice to establish class membership. Indeed, the introduction of class properties leads to the proliferation of classes that Carstairs (1983) discusses under the rubric of 'paradigm economy'. This is not the place for an extended treatment of these issues, though see Lieb 2003 for discussion of the role of forms in classical WP models and Blevins 2003 for discussion of the problems that diacritic class features raise for SP models.

4.2. RECURRENT OPERATIONS. The operation- and index-based alternatives set out above both develop the idea that a purely morphological 'level' mediates between substantive morphosyntactic properties and their formal realization. The operation-based approach in §1.3 implements this idea in terms of recurrent operations, whereas the index-based approach in §1.4 introduces the series index [DENT] and the form-class property [PART]. This section identifies some important points of contact and divergence between the operation-based analysis and approaches based on morphomic functions or referral relations. Section 4.3 turns to the antecedents of the index-based analysis.

MORPHOMIC FUNCTIONS: The operations in §1.3 differ only slightly from what Aronoff (1994) terms morphomic FUNCTIONS. Aronoff (1994:45) defines the function F_{en} as follows:

> the perfect participle is a kind of abstract category realized in the context of a given verb through the operation of one or more of a set of realization rules of suffixation or ablaut, the default realization being *D*. Perfect Participle is therefore a discontinuous morphophonological function . . . for every verb lexeme, there is a single perfect participle, although not all perfect participles are derived by the same rule. Let us call this morphophonological function from verb stems to perfect participles F_{en}.

F_{en} is 'discontinuous' in the sense that it invokes different operations, depending on the type of its input. A default operation forms regular participles by suffixing the exponent that Aronoff represents as *D* above. Aronoff also assumes that irregular participles like *left*, *sung*, and *bought* are formed from verb roots. Hence, for each irregular class there will be a corresponding minor operation.

Viewed more abstractly, a morphomic function F_{en} is a set of pairs $\langle \alpha, X \rangle$, where the first element, α, is a verb stem, and the second element, X, is the corresponding perfect participle form.[27] For weak participles, F_{en} will have the same effect as the operation F_d. For strong participles, F_{en} can, as Aronoff supposes, invoke a minor rule of the sort proposed by Halle and Marantz (1993). Alternatively, F_{en} can simply enumerate all of the suppletive stem-participle pairings.

Aronoff suggests that the inventory of morphomic functions in a language constitutes an independent—and inherently morphological—level. This level is itself neither morphosyntactic nor morphotactic, but rather mediates between features and their realization: 'the mapping from morphosyntax to phonological realization is not direct, but rather passes through an intermediate level' (Aronoff 1994:25). Although Aronoff does not formalize this proposal, a straightforward formalization would introduce morphomic functions within realization rules, essentially as in Table 9.

An account of WG conjugations based on morphomic functions would thus be very similar to the analysis proposed above in terms of morphomic operations. Both analyses exploit the separation between rules and functions or operations in a realization-based approach. Hence distinct rules may share a function or operation, and distinct functions may even invoke a common operation.

RULES OF REFERRAL: Like Wurzel's 'paradigm structure constraints' (Wurzel 1989), the rules in Table 9 express correspondences between forms in a paradigm. Stating these correspondences in terms of shared operations and variables avoids the need to assign priority to the realization of any one rule, unlike standard referral rules (Zwicky 1985, Stump 1993b). For example, in Zwicky's initial proposal (1985:372), perfect participles in English are defined with reference to preterits, rather than vice versa, even though there is no obvious basis for deciding which form is 'parasitic' in this case.

> 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].

As a referee observes, Zwicky's decision to define regular participles in terms of preterits in English could be justified on the grounds that it predicts the absence of preterit forms in *-en*. Yet it is not altogether clear that this sort of pattern calls for a

[27] That is, F_{en} is thus, as Aronoff suggests in the passage above, a 'morphophonological function from verb stems to perfect participles', not, as he proposes later, a function whose domain is 'the class of verb lexemes' (Aronoff 1994:25).

synchronic explanation. The syncretism between regular participles and preterits in English reflects two separate morphotactic developments: the loss of the prefix *ge-* in the participial system, and the gradual erosion of suffixal inflections in the preterit system. As a result of these changes, regular participles and preterits are both realized by the 'bare' dental stem. The processes of morphotactic simplification that yield this syncretism provide no basis for the innovation of preterit forms in *-en*. The participial forms in *-en* that have been retained in Modern English are not sufficiently numerous to influence the formation of new participles, let alone preterits. It is, in fact, only if one assumes a referral analysis that one must guard against generalizing a frozen participial pattern to preterits. A referral analysis that defines participles in terms of preterits is perhaps preferable to one that defines preterits in terms of participles, but neither offers a particularly suitable treatment of the patterns of syncretism in WG conjugations.[28]

4.3. MORPHOMIC INDICES. The index-based analysis in §1.4 develops the type of 'mediated' realization-based approach outlined in Spencer 2001 and Ackerman & Stump 2003. In this approach, substantive morphosyntactic properties are systematically related to pure form features, and the form features are in turn spelled out by realization rules. To a large extent, the differences between operation- and index-based analyses are tactical rather than strategic. Either approach can provide an analysis of the patterns described above. Moreover, a comparison of the rule sets in Tables 9 and 10, or the analyses in Tables 11 and 12, mainly highlights the trade-off between the operation and rule 'overhead' of an analysis based on morphomic operations and the feature overhead required for mediated spell-out rules.

The use of substantive and form features introduces a potential concern about consistency in the evaluation of alternatives. A morphemic analysis of the past series fails because stems in *-d/t* realize no constant meaning. But if realization rules are allowed to spell out form-class properties like '[DENT]', along with substantive properties, it might be objected that the descriptive success of a realization-based model rests on a more permissive notion of what counts as a property. The operation-based analysis proposed above is not open to this objection, as it restricts spell-out relations to substantive morphosyntactic properties. An approach in which realization rules always spell out form features would likewise be immune to this objection. In this model, outlined in Stump 2002, realization is a two-step process of deducing form features from substantive properties, and then spelling out form features. Yet one might simply challenge the original objection by observing that all current feature systems are heterogeneous. The features [+ PAST] and [+ PARTICIPLE] designate form classes in Halle & Marantz 1993, as do [FORM] features in lexical functional grammar, and [VFORM] features in generalized phrase structure grammar and HPSG.

There is, moreover, at least one empirical consequence of using indices rather than operations. An analysis that invokes shared operations is essentially restricted to regular patterns that can be regarded as BUILT or ADMITTED by regular rules that introduce a stem in *-d/t*. An operation-based account accommodates full-word suppletion by means of lexeme-specific rules that are more specific than basic stem or exponent rules. There

[28] These considerations do not, of course, militate against referral analyses of other types of syncretism, nor are they meant to call into question the usefulness of distinguishing systematic from accidental homophony, which is defended at some length in Zwicky 1991. Stump 1993b provides a general discussion of standard referral rules, and Stump 2001:222 extends this rule format by a symmetrical syncretism metarule that applies to nondirectional patterns.

is no obvious way to integrate suppletive dental stems, since the operations that introduce dental stems are encapsulated in the rules in Table 9. In contrast, the treatment of suppletion in an indexing account applies equally to stems and to words, since both are assigned a lexeme and series index. This extension would offer an account of MIXED patterns in WG, in which a strong stem takes weak endings. Some German examples are given in Table 20.

The suppletive dental stems in Table 20, *bracht* and *brannt*, underlie regular preterit and participle forms. That is, it appears that lexicalized dental stems are 'feeding' the regular rules in Table 10. Mixed patterns are found in other WG languages, though the types of mixture that they exhibit depend on the morphotactic structure of a language. As a referee notes, English retains patterns such as *sell~sold~sold*, in which a putative strong stem *sol* underlies regular preterit and participial forms, alongside patterns such as *feel~felt~felt*, in which *fel* occurs with *-t* rather than the expected *-d*.

VERB	ROOT	DENTAL STEM	PRETERIT	PERFECT	PASSIVE	GLOSS
BRENNEN	brenn	brannt	brannte	gebrannt		'burn'
BRINGEN	bring	bracht	brachte	gebracht		'bring'

TABLE 20. Mixed patterns in German.

It is reasonably clear that an index-based approach provides an analysis of mixed patterns that cannot be reconstructed in terms of shared operations. What is not quite so clear is that speakers extract generalizations out of mixed patterns, rather than encapsulating them in suppletive word forms. The studies reported in Clahsen 1999 found that at least some mixed patterns in German are treated as unanalyzed words; it remains to be seen whether this is true of all mixed patterns.

THE ROLE OF CONSTRUCTIONS: The analyses proposed above assume that the properties [PERFECT] and [PASSIVE] are associated with homophonous participles in WG. This assumption is uncontroversial in most lexicalist approaches to syntax and morphosyntax. Morpheme-based accounts likewise distinguish perfect from passive participles in WG, even though they ultimately regard morphs as the privileged point of entry for aspect and voice properties. The existence of distinctive participles is, however, not necessarily assumed by classical WP models, as Robins (1959:124) makes clear: 'Paradigms are primarily and mainly of single words, but where short groups of words or phrases (e.g. Latin, and some Greek, perfect passives) are syntactically comparable to single words in the corresponding places of a different paradigm they are obviously to be included in the paradigms themselves'.

The idea that periphrastic perfect and passive constructions are 'forms' of a main verb underlies the description of English in sources like Curme 1935. The same intuition is developed in a more explicit way in Ackerman & Webelhuth 1998, and in a number of subsequent accounts, such as Spencer 2001 and Ackerman & Stump 2003. These approaches identify a 'past participle' that is common to perfect and passive constructions in various languages. In English, for example, the property [PERFECT] would be realized by a form of auxiliary HAVE and the past participle. The property [PASSIVE] would likewise be realized by a form of BE and the same past participle. This approach raises a broad range of questions, some of which are discussed in a summary way in Blevins 2001b. There is no doubt, however, that the introduction of a single 'past participle' provides a direct and elegant account of the syncretism between perfect and passive constructions.

4.4. PSYCHOLINGUISTIC IMPLICATIONS. Since the present account bears in various ways on assumptions about the mental lexicon, it may be appropriate to conclude with some general remarks about the psycholinguistic implications of the type of analysis proposed here. The contrasting analyses assigned to weak and strong forms are supported by well-established differences between the processing of regular and irregular inflection. Psycholinguistic studies show that regular participles in *-t* in German 'exhibit full priming effects' on their roots, whereas strong participles in *-en* exhibit 'only partial priming' (Clahsen 1999:1001). Conversely, in lexical decision tasks, Clahsen (1999: 999) reports 'word-form frequency effects for participles of different subclasses of strong verbs but not for *-t* participles of weak verbs'. Within a DUAL MECHANISM (Clahsen et al. 1997) or WORDS AND RULES (Pinker 1999) model, these contrasts reflect a difference between BUILT and STORED forms. Clahsen (1999:1001) suggests that '*-t* participles are decomposed into stem + affix and therefore priming toward other corresponding word-forms can be directly mediated via the stem', whereas strong participles are lexically represented as wholes.

The discovery that strong participles do not strongly activate the root form of a verb is very much as one would expect, given that the strong patterns are no longer productive in German, or in WG generally. It is natural that these forms should be stored in the mental lexicon of a German speaker, rather than derived by lexeme-specific ablauting processes. Yet it does not follow that regular formations are not ALSO stored as wholes. Indeed, as Booij (1999:1016) and Bybee (1999:1017) point out, there is strong evidence that high-frequency regulars are in fact stored as wholes.

Clahsen (1999:1052) attributes the whole-word properties of high-frequency regulars to 'memory traces'. This may be the correct interpretation, but the fact that high-frequency regulars show full-form frequency effects is essentially what a classical WP model would predict. If an inflectional system consists of inflected word forms and constraints that permit the deduction of new forms, one would expect that high-frequency regulars will be stored, and low-frequency regulars will be deduced. Irregulars must be stored, irrespective of their frequency, since they cannot be deduced.

The observation that regular formations prime roots follows if constraints like those in Table 9 or Table 10 are involved in the processing of regulars. That is, the 'activation' of roots is just as compatible with a WP model in which roots are deduced from inflected word forms as it is with a model in which roots are retrieved from a lexicon. It is often assumed in psycholinguistic studies that priming implicates retrieval, though it is not clear that there is any empirical support for this tacit premise.

More generally, existing studies establish that irregular formations and high-frequency regulars are both stored as whole words. What has not really been shown is that the parts of any regular inflectional formation are stored separately. There is indisputably a strong connection between regular forms and their stems. But this connection also follows from a word-based model in which stems are deduced from inflected word forms. Hence a classical WP model can be regarded as an idealization of an associationist network (Rumelhart & McClelland 1986), in much the same way that ENTRY AND RULES models are idealizations of more symbolic models of the mental lexicon.

This may or may not be the correct conception, but it shows how a WP model can offer a fresh perspective, not only on patterns within a system, but also on the implications of those patterns.

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