Early Generative Model (Chomsky & Halle 1968, aka SPE)

[1] basic properties
- unpredictable features of lexical item stored in permanent linguistic memory (lexicon);
- predictable features assigned by phonological rules
- phonological rules convert surface syntactic structures to phonetic representations
- lexical and grammatical formatives represented as strings of distinctive feature matrixes
- at both the underlying, phonological level and the surface, phonetic level
- phonological rules are context-sensitive rewrite rules that alter feature structure (A -> B /X_Y) or delete, insert, reorder entire segments
- the rules apply in a linear sequence and form a partially ordered set
- some rules apply at the level of the word (e.g. Vowel Shift) and others at level of the phrase (e.g. Nuclear Stress Rule)
- some rules may apply in a cycle
- focus on alternations to discover the rules (if alternations are regular then speaker/learner posits a single underlying form from which the different phonetic variants can be derived by context-sensitive rules)
- concern with explicitness and formal statement
- tremendous success; many languages analyzed by MIT's first generation of graduate students: French (Schane), Spanish (Harris), Russian (Lightner), Japanese (McCawley), Sanskrit (Zwicky), Latin (Foley), Turkish (Lees), Menomini (Bever), Mandarin (Woo); new generalizations discovered or old ones viewed in a different light. [MIT Dissertations: http://libguides.mit.edu/diss]
- rules do not aim at particular structures; functional explanations viewed with suspicion
- principles of morpheme and word-shape (phonotactics) of limited interest (but see Stanley 1967); no concern for variation or frequency; focus on “deeper” morphophonemics rather than "lower-level" phonetic processes.

Illustration from SPE's analysis of English segmental phonology (SPE Chapter 4)

[1] vowel reduction: when unstressed, short vowels appear as [ə] (or [i] if high)

<table>
<thead>
<tr>
<th>Word</th>
<th>Vowel Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>télégraphe</td>
<td>[ε] = [ə]</td>
</tr>
<tr>
<td>télegraphe</td>
<td>[ə] ≈ [ɛ]</td>
</tr>
<tr>
<td>atom, atómic</td>
<td>[æ] ≈ [ə]</td>
</tr>
<tr>
<td>arôma, àromátic</td>
<td>[ə] ≈ [æ]</td>
</tr>
<tr>
<td>origin, oríginal</td>
<td>[ə] ≈ [a]</td>
</tr>
<tr>
<td>órigin, oríginal</td>
<td>[ε] ≈ [ə, i]</td>
</tr>
</tbody>
</table>

- schwa is predictable variant of full vowel in unstressed syllable: if we start with schwa we cannot predict which vowel will occur under stress (source of many spelling errors)
• problem for Autonomous (Structural) Phonemics: violates the invariance condition and yet schwa presumed not to be phonemic

[2] Flapping and vowel length: two famous sound alternations (Chomsky 1964)

• American Structuralists concerned with contrast; intuition that while aspirated [pʰ] of English pool and Korean pʰul ‘grass’ are phonetically equivalent, they have distinct linguistic status; in Korean aspiration is contrastive while in English it is not
• contrast is to be represented as a level of the grammar (the phonemic level) where only contrastive sounds (distinctive features) are represented; noncontrastive sounds (features) are allophones restricted to the phonetic level: English /pul/- > [pʰul] vs. Korean /pʰul/- > [pʰul]
• procedures of analysis proposed to discover the phonemes; complementary distribution and minimal pairs (see Zellig Harris 1951)

• English flapping:
  a[r]om, a[tʰ]omic  be[d],  be[r]-ing  (cf. Spanish where /d/ and /t/ contrast)
  [t,d] - > [+sonor] / ‘V — V (V = stressed vowel)

• vowel length:
  vowels shorter before [-voice] consonants: hît [i] vs. hid [ɛ]; bêt [ɛ] vs. bed [ɛ:]
  • Canadian raising  tie  tight  tide  cow  out  crowd  type  bike
    RP, GA  aj  āj  aj  aw  āw  aj  āj
    Canadian  aj  āj  aj  aw  āw  āj  āj

    V - > [-long] / _ _ ([syll] )[-voice]
    ā - > [-low] / _ _ [+ high]

• conclusion: flap [r] and mid-vowel diphthongs [āj] and [āw] are not phonemes given their limited and predictable distribution

• writer [āj] vs. rider [āw] (Bloch 1942)
  minimal pair: [rājɾəɾ] vs. [rəɾəɾ]; seems to indicate that the [aj] vs. [āj] difference is contrastive (phonemic) despite its limited and otherwise predictable distribution
  but the difference is completely predictable if phonological processes apply sequentially to modify an underlying representation composed of unpredictable information

<table>
<thead>
<tr>
<th></th>
<th>/əɾjt/</th>
<th>/əɾjt-əɾ/</th>
<th>/əɾjd/</th>
<th>/əɾjd-əɾ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>ājtering</td>
<td>ājtering</td>
<td>-----</td>
<td>--------</td>
<td>vowel shortening before [-voice]</td>
</tr>
<tr>
<td>rājtering</td>
<td>rājtering</td>
<td>-----</td>
<td>--------</td>
<td>Canadian Raising</td>
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<tr>
<td>--------</td>
<td>--------</td>
<td>------</td>
<td>--------</td>
<td>Flapping</td>
</tr>
</tbody>
</table>

1 ‘invariance’ was the hypothesis that each phoneme is distinguished by a core of properties that appears in every phonetic realization of the sound.
• Chomsky concludes that there is no autonomous phonemic level between the Underlying Representation and the Phonetic Representation
• Focus of analysis shifts to alternations

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<tbody>
<tr>
<td>serène</td>
<td>serénty</td>
<td>prosper</td>
<td>prosperité</td>
<td></td>
</tr>
<tr>
<td>profáné</td>
<td>profánity</td>
<td>final</td>
<td>finálity</td>
<td></td>
</tr>
</tbody>
</table>

| [aj] | [i] | [i] | [i] |
| [ij] | [ɛ] | [ɛ] | [ɛ] |
| [ej] | [æ] | [æ] | [æ] |

analysis:
• a quantitative alternation (long diphthong ≈ short lax vowel) as well as a difference in vowel quality
• suffixed form reveals the underlying quality of vowel; but to distinguish from stable short vowels in rigid, rigidity, etc. the alternating vowels must be underlyingly long; hence div/iː/ne, ser/eː/ne, prof/æː/e; their quality is changed by shifting the nucleus of the diphthong (a change that is recurrent in the history of English)²

V: - > Vj  long vowel diphthongizes
[-low, αhigh] - > [−αhigh] / ___ j  ij and ej interchange nuclei
[-high, αlow] - > [−αlow] / ___ j  ej and aj interchange nuclei

• some rule must shorten the root vowel when certain affixes are added:
  Trisyllabic Laxing:  V - > [−long] / ___ CnVCnVCn#
• the analysis entails that the underlying vowel never surfaces as such: it is always changed either in quantity or else in quality. But this is exactly what is expected if rules apply mechanically in sequence (without regard to their consequences).

Order: TSL precedes Vowel Shift, which itself is composed of three ordered sub-rules

/ divine/  / divin-i/ti/
-------  divinti  Trisyllabic Laxing
divijn  ------  diphthong formation
divejn  -------  Vowel Shift I
divæjn  -------  Vowel Shift II

² See SPE (Chapter 6) and Labov (1994).
• while one might postulate rules that directly relate the surface vowels (e.g. [aj] - > [i] / __ CoVoCo#), there is independent evidence that [aj] derives from /i:/.

[4] Velar Softening (velar palatalization before front vowels is a common sound change: cf. Slavic, Mandarin)

<table>
<thead>
<tr>
<th>critic</th>
<th>critic-al</th>
<th>critic-ism</th>
<th>critic-ize</th>
</tr>
</thead>
<tbody>
<tr>
<td>medic</td>
<td>medic-al</td>
<td>medic-ine</td>
<td>medic-ate</td>
</tr>
<tr>
<td>allege</td>
<td>alleg-ation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rigid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>reg-al</td>
<td>regicide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>analogous</td>
<td>analog-y</td>
<td>analog-ize</td>
<td></td>
</tr>
</tbody>
</table>

[k, g] -> [s, dʒ ~ ʒ] / __ [-cons, -low, -back]\(^3\)

precedes Vowel Shift for two reasons:
- in critic-ize Vowel Shift alters the context to a low vowel ("counterbleeds")
- in medic-ate Vowel Shift creates a front mid vowel that fails to soften the velar ("counterfeeds")

/kritik-i:z/ /medik-æ:t/
Kritis-i:z ----------- Volar Softening
Kritis-ajz medik-ejt Vowel Shift

[5] blocking condition on rules

\[
t -> s / _-ive, -y \quad \text{permit} \quad \text{permiss-ive}
\]
\[
\text{democrat} \quad \text{democrac-y}
\]
\[
\text{but digest} \quad \text{digest-ive}
\]
\[
\text{honest} \quad \text{honest-y}
\]
\[
s -> f / _j \quad \text{regress} \quad \text{regre[f]-on}
\]
\[
\text{rebel} \quad \text{rebel-[j]on}
\]
\[
\text{permit} \quad \text{permi[f]-on}
\]
\[
\text{explode} \quad \text{explo[5]-on}
\]
\[
\text{but digest} \quad \text{diges[t]-on}
\]

\(^3\) The statement of the structural change in features is tricky and requires a special mechanism (p. 224) that changes the input to [+anterior] if [-voice], somewhat analogous to OT’s *f* > *s.
• t -> s rule is blocked after s
• avoid sequence of spirants: *s s
• cf. plural zebra-[z], dog-[z], ram-[z], bed-[z], rat-[s], bush-[iz], bus-[iz]
• is this the same grammatical phenomenon? Not obvious how *s s can both block rules like t -> s and trigger insertion of schwa; a basic motivation for the OT model

[6] s-voicing: at prefix stem boundary /s/ is voiced between vowels

\[
\begin{align*}
\text{con} & = \text{sume} \quad [s] & \text{re} & = \text{sume} \quad [z] \\
\text{in} & = \text{sist, per} = \text{sist} & \text{re} & = \text{sist} \\
\text{con} & = \text{sign} & \text{re} & = \text{sign}, \text{de} = \text{sign} \\
\text{con} & = \text{serve} & \text{re} & = \text{serve}, \text{de} = \text{serve}
\end{align*}
\]

s -> [+voice] \quad /V = ____ V

apparent exceptions explained by rule ordering: (counterfeeding)

\[
\begin{align*}
\text{con} & = \text{cede} \quad [s] & \text{re} & = \text{cede} \quad [s] \\
\text{in} & = \text{cite} & \text{re} & = \text{cite}
\end{align*}
\]

/re = ki:t/

-------- s-voicing
\text{re} = \text{si:t} \quad \text{Velar-Softening}
\text{re} = \text{sajt} \quad \text{Vowel Shift}

[7] ks-voicing:

\[
\begin{align*}
\text{ex} & = \text{amine} \quad [gz] & \text{vs.} & \text{ex-ceed} \quad [ks] \\
\text{ex} & = \text{alt} & \text{ex} & = \text{cite} \\
\text{ex} & = \text{ist}
\end{align*}
\]

/eks = ke:d/ /eks = ist/

-------- egz = ist \quad \text{ks-voicing}
\text{eks} = \text{se:d} \quad -------- \quad \text{Velar Softening}
\text{eks} = \text{sijd} \quad -------- \quad \text{Vowel Shift}
\text{eksijd} \quad -------- \quad \text{Degemination}
[8] more prefixes: \( C \to C^* / \_
\) = \( C^* \) (a subset of prefixes completely assimilate to the following consonant)

- ad = here  sub = due
- ad = mire  sub = sist
- at = test  sup = port
- as = sist  suf = face
- an = noy  sub = merge
- ac = cuse  suc = cumb

- ac = cede \([s]\)  suc = ceed \([s]\)  sug = gest \([d]\)

/sub = ke:d/
- suk = ke:d  assimilation
- suk = se:d  Velar Softening
- suk = sijd  Vowel Shift

rule ordering:  
\[
\begin{array}{cccc}
s-voicing & place assimilation & ks voicing \\
\backslash & | & | \\
\text{trisyllabic laxing} & \text{velar softening} & \\
| & / & \backslash \end{array}
\]
\text{vowel shift}  \quad \text{degemination}

[9] the cycle: Chomsky, Halle & Lukoff (1956) show that the stress contours of English compounds and phrases can be computed by simple rules that track the syntactic constituent structure, working from the inside out.

**Compound Stress vs. phrasal stress (Nuclear Stress Rule)**

- Whit
d* House  the\* white h*orse
- bl\*ackb*oard  a bl\*ack d*ress

**Compound Stress:** make the stress of the first constituent primary [1] and reduce the other by one degree

- \[ [ [black] [board] ] [eraser] ]
- Word Stress
- Compound Stress: first cycle
- Compound Stress: second cycle

bl\*ack- bo\*ard er\*aser
SPE suggests applying cyclic stress to word-internal structure

[ [ theater ] ic + al ] ity (cf. origin-áility vs. ábracadábra, Winnepesáukee

1 theater cycle 1
2 1 theatric cycle 2
3 2 théàtricáility cycle 3

Some subtle vowel contrasts explained in words that have the same surface stress contours:

<table>
<thead>
<tr>
<th>Word</th>
<th>Surface Stress Contour</th>
</tr>
</thead>
<tbody>
<tr>
<td>relaxátion</td>
<td>æ</td>
</tr>
<tr>
<td>emendátion</td>
<td>e</td>
</tr>
<tr>
<td>domesticity</td>
<td>æ</td>
</tr>
<tr>
<td>torment</td>
<td>e</td>
</tr>
<tr>
<td>cónvict</td>
<td>i</td>
</tr>
<tr>
<td>prógress</td>
<td>æ</td>
</tr>
<tr>
<td>devastátion</td>
<td>æ</td>
</tr>
<tr>
<td>devastation</td>
<td>a</td>
</tr>
<tr>
<td>opportunity</td>
<td>a</td>
</tr>
<tr>
<td>tóront</td>
<td>æ</td>
</tr>
<tr>
<td>tórent</td>
<td>æ</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Word-Stress: cycle-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1 1 0 2</td>
</tr>
<tr>
<td>3 2 1 2 0 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vowel Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1 1 0 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stress Clash: remove medial stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 1 1 0 2 1</td>
</tr>
</tbody>
</table>

Stress in English bases

Verbs and adjectives

<table>
<thead>
<tr>
<th>Word</th>
<th>Stress Contour</th>
</tr>
</thead>
<tbody>
<tr>
<td>astónish</td>
<td></td>
</tr>
<tr>
<td>maintáin</td>
<td></td>
</tr>
<tr>
<td>lamént</td>
<td></td>
</tr>
<tr>
<td>imáginé</td>
<td></td>
</tr>
<tr>
<td>eráse</td>
<td>a</td>
</tr>
<tr>
<td>usúrp</td>
<td></td>
</tr>
<tr>
<td>devélóp</td>
<td></td>
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<tr>
<td>cajóle</td>
<td></td>
</tr>
<tr>
<td>cavórt</td>
<td></td>
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<tr>
<td>sólíd</td>
<td></td>
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<tr>
<td>supréme</td>
<td></td>
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<tr>
<td>robúst</td>
<td></td>
</tr>
</tbody>
</table>
cómmon  secúre  diréct  
vúlgar  ináne  ovért  

nouns  
América  aréña  ásterisk  
metrópolis  horízon  lábyrinth  
vénison  aróma  appéndix  

• in nouns, words ending in consonant clusters are treated as “extrametrical”  

complex verbs  derived nouns  
per=mít  pér=mit  (cf. fórfeit, hermit)  
trans=fér  tráns=fer  
com=pél  pró=tèst  (cf. déntist with flap)  

• in verbs with latinate [prefix=root] structure, the prefix is unstressible (extrametrical).  
But on the noun cycle this internal structure is no longer visible (subjacency) and so  
per=mit (0 1) > (1 2). The surface 1 0 contour derives from another rule of stress clash  
reduction on weak syllables.

Chomsky, Noam, Morris Halle, and Fred Lukoff. 1956. On accent and juncture in English. For  