The idea of milking chains by overlapping words is due to H. E. Dudeney, and is probably a follow-on of Lewis Carroll's word ladders. Dudeney used words of uniform length and constant overlap. Christopher McManus introduced Word Ways readers in November 1990 to Ana-Gram-Mar (AGM) chains, ones in which the word length may vary, but there is always single overlap (each letter appears in exactly two words): house-man-slaughter-house, gosspol-yester-morning-tide-water. In the May 1991 Word Ways, Ross Eckler called the Dudeney chains directed word chains and introduced notation for word length and degree of overlap. However, it is misleading to restrict the term directed word chains to only those having words of fixed length; AGM chains are directed as well. It is more useful to regard AGM chains as a special case of directed word chains. In three articles beginning in August 1991, I explored AGM chains. I call word parts frags; sometimes frags are words, sometimes not. Most of my work has been with (8,4) chains, such as tops-oils-kins-folk. In this article I consider directed word chains with words of uniform length (some are AGMs).

My database is mostly Websterian. My lists are about one-and-one-half times as long as the Official Scrabble Players Dictionary (my initial source), but short of Web 2 and Web 3. All words are lower case. A nice feature of these chains is that although many include words that are not common today, their meaning is apparent. My lists are restricted to lower case words as a consequence of my start with the OSPD.

Chains were devised by hand, but with the mule work done by computer. I used BASIC programs to create special lists and the standard WORDPERFECT search program to develop chains. A word processor in conjunction with BASIC is a most powerful tool.

**Nine-Letter Ana-Gram-Mar Chains**

There are different ways to chain words containing an odd number of letters. In the following chains of nine-letter words, frag lengths alternate 4-5-4-5-. My first step in boiling 26,300 nine-letter words down to a useful set was to collect and sort four- and five-letter beginning and ending frags. There were 7400 (4100) different four-letter beginnings (endings), and 13800 (9300) different five-letter beginnings (endings). Later steps selected words in which the left frag of length n was found in the list of right frags of length n, and the right frag of length 9-n was found in the list of left frags of length 9-n. The process was repeated several times to condense the resultant to core words. Two classes of words resulted, splitting 5-4 and 4-5; a few words appeared in both classes.

In the following heads, rain starts, both classes of paths between.

Startling-lingering-startling-book,-

room-stand-far-stand-room

lady-birds-eye-fire-break-wise-crack

hand-shake-test-cross-over

green-head-grass-fire

flash-back-dream-tide

**Nine-Letter Word Chains**

(M,n) chains extend the previous set of words so that the left frag of length m is found in the May 1991 set of words and analogous to the previous chain. The following chain is made good by the mule work; many words are not common today.

Railroads travel steady d y

**Eight-Letter Words**

With (m,n) parameters the letter second in the following
in both classes.

In the following chains, note the separate usage of head and heads, rain and rains, etc. Note the use of overtrain and downstart, both divided two ways. No effort was made to find minimum paths between end words.

video-disc-overt-rain-water-work-horse-back-cross-over-train-sick-rooms-theadishes
room-stead-fast-backs-trap-light-ship-board-room (a ring)
head-stone-wall-paper-back-stage-hand
rains-torm-enter-mete-yards-tick-birds
lound-mouth-part-ridge-bone-heads

3. All words appear in both classes.

in the following chains, note the separate usage of head and heads, rain and rains, etc. Note the use of overtrain and downstart, both divided two ways. No effort was made to find minimum paths between end words.

video-disc-overt-rain-water-work-horse-back-cross-over-train-sick-rooms-theadishes
room-stead-fast-backs-trap-light-ship-board-room (a ring)
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Nine-Letter Words, One-Letter Overlap

(M,n) chains use words of length m, each of which overlaps the previous by n letters. In the simple case, m and n are chosen so that the third word begins at the end of the first. However, when m is odd and n = (m+1)/2, there is one-letter secondary overlap. Eckler exhibits a network of interlocking (3,2) chains in the May 1991 Word Ways. Here, I construct (9,5) chains. The set of words useful for this kind of chain (obtained by procedures analogous to the ones described previously) is almost as large as the previous one, but the words are not as well-connected. The following are the longest chains I can make. This type of chain is more appropriate for short words, but nine-letter words make good puzzles.

railroads trichomes thousands eleganter
roadstead homestall sandsoaps anterooms
steadying stallions soapstone roomstead
dyingness lionships stoneface steadfast
shipshape diestrous shapeless

eight-Letter Words, Secondary Overlap

With (m,n) chains, if m is even and n = 1+(m/2), we have two-letter secondary overlap. There is not much in the way of length in the following (8,5) chains, but these also make good puzzles.

railroads trichomes thousands eleganter
roadstead homestall sandsoaps anterooms
steadying stallions soapstone roomstead
dyingness lionships stoneface steadfast
shipshape diestrous shapeless
displace subhuman madwoman citharas confines
placement humanest womanise harasses finespun
entering stricter seedsman essorant undialed
chasuble eringoes icterode
sublease erodents accoutre madoquas
leaseman profiles outreach madoquas
semantic filespec reaching assassin
anticked especial chingmas assinego

Seven-Letter Words, Secondary Overlap

Here is an introduction to the (7,4) chain. Now the game gets interesting!
rusalka isotach
alkalis unscrew tachist
alismas crewels histrio
chasuble eringoes icterode
fiurama sheriff trionym antonym
marabou riffles singing mousling
aboulic flesher singing gingham gingeli
constat roocher disturb gelidly
descent statant thereto turbeth
centric tantric retours bethumb carcass
tricorn tricars orself humbugs cassava
finarch tamise cubist newest
netting sicking fishing shastra annatta
TINGLED KINGING HINGING STRAINS ATTAINS
pledged gingall ainsell
galoot sellout louting
looting louting tinging

Six-Letter Words, Secondary Overlap

Here are (6,4) chains. Six seems to be the best length for this. These are well-enough connected to allow branching, but I have not found closed loops or enough joins to identify a core (it's close). Analysis of a slightly-larger database should prove useful.
m'lniac albata
niacin batata brenne
acinar tatami incubi ennewe
finarch tamise cubist newest
archil misere bistro westar
replan chilli serene stroke stares
planch illite renest rokete areste
anchor litera nester ketene esteem
choral teraph steric tenere teemer
allyic phaeic icasms reises erodes

Chaining Words of Mixed Length

Neither eight- nor nine-letter words produced long chains with secondary overlap, so here are chains using eight- and nine-letter

words together vicious one by one. Enter ten-letter
executor scuterbra rebranching
prolonge

Puzzle 1

Fill the blank
1. cock
2. brain
3. ship
4. trans
5. paper
6. ball

Puzzle 2

Provide extensions to produce two words to produce two
words answered by mon-
is answered by non-
Answers can be

-bility
-which
-door
-frame
-no-
-te-
the game gets
longer. but I have
had to prove useful.

words together. My rule is that every word must overlap the pre­
vious one by five letters. In the future, I will show what includ­
ing ten-letter words allows.

e:executer schmucks cuterebra mucksweat rebranch sweatweed ranchero tweediest cheroots diestrous rootstock toulouse
prolonge stockings calamari amarillo
longears
longears
longears
longears
longears
longears
longears
longears
longears

Puzzle 1
Fill the blank with one word so as to make two more nonoverla­
ping words (i.e., a four-link AGM chain). The filler may be of
any length - the longer, the better.

1. cock- -fatter 7. ship- -worm
2. brain- -power 8. show- -pieces
3. ship- -craft 9. cross- -talk
4. trans- -dress 10. sheep- -breeder
5. papers- -eller 11. corn- -picker
6. ball- -head 12. hand- -spring

Puzzle 2
Provide extensions in both directions from the following so as
to produce two overlapping words. The longer the overlap, and
the longer the words, the better. For example, -ignoratio- is answ­
ered by monsignor and rationale, which overlap at R; -hatcheck­
is answered by nuthatch and checkout, which overlap at CH. These
are neither AGM chains nor directed word chains, but a more gen­
eral case.

-blastular- -pediatric- -semester-
-wheatears- -pediatric- -semesterc
-downswing- -damascene- -spacemen-
-fron tally- -sighthole- -turnover-
-desisting- -sovereign- -clothing-
-novelette- -archenemy- -commander-
majorette- -outreach- -billions-
-tempress- -mentally-

Answers can be found in Answers and Solutions at the end of this
issue.