they be fatal. What gets your books "out" is the publisher's distribution machinery, and what gets them sold is what was in your manuscript.

Of course, you are entitled to the most help your publisher can give you. If I have any message, any "pitch" for prospective authors, it is this: don't enter into a publishing arrangement blindly. Ask questions, seek the counsel of other authors, talk to editors, learn what they have to offer. Also, inspect related books in your field, and note the presentation that different publishers have given them. Then, when you do sign a contract, do so with the feeling that you accept partnership willingly and unreservedly.

Remember Ben Franklin's admonition: "Keep your eyes wide open before marriage, and half shut afterwards." The author-publisher partnership is not quite marriage, and you should certainly not close your eyes, even halfway, but it does help to expect only the best of your publisher. Your attitude will help him to expect it of himself.

Speaking of Space

The major part of "space speak" shows abundant use of a single grammatical form available in general English.

David McNeill

We read of "space speak" on every hand. Newspapers and magazines discuss it in their science columns, and popular fancy seems to have been captured by it. The belief is that the space effort has given us, in addition to the possibility of going to the moon, a new linguistic phenomenon. However, it is not easy to escape the confines of English, and in "space speak" there is nothing novel, nor even very much that is unique. The name itself is a misnomer. "Space speak" is not much spoken; and, linguistically, the most important thing that NASA engineers do is not peculiar to the space effort. On the other hand, there is a jargon of engineering that is fully used by space technologists. My task in this article is the analysis of such jargon.

The major part of space jargon is an overabundance of a linguistic form that is available to all speakers of English. There is, however, a much smaller part that is unique; these are the words, seemingly occult, that give rise to the impression of linguistic novelty. Some familiar examples are *pad, abort, umbilical.* Others, less well known, are *eyeballs in* and *eyeballs out* (describing conditions of extreme acceleration and deceleration respectively) and *milk stool* (describing an arrangement of three rocket engines on the lunar spacecraft). As these examples show, such terms in the jargon of space engineering are of two types. Most are metaphors (for example, *umbilical, milk stool*), where the conventional meaning of the word and its meaning in space jargon have something in common. A much smaller number are metonyms (for example, *eyeballs in*), where the conventional term refers to something that typically accompanies the referent of the space term. Metaphors depend on similarity of referent; metonyms depend on contiguity. Both types of term are the ingredients of most professional jargons. Psychologists, for example, talk of *thresholds*; anthropologists, of cultural *diffusion*; sailors, of *Jacob's ladders.*

Metaphors and metonyms are usually apt, but, by the same token, they are difficult to come by. The process of finding a good metaphor or metonym is not given automatically by the rules of English syntax. It demands a kind of creativity that is unregimented. Thus, whereas metaphors and metonyms are ordinarily "good," in the sense of capturing an intended meaning succinctly and vividly, they are also rare. If a technical jargon must provide large numbers of terms, reliance on metaphors and metonyms simply will not be sufficiently productive.

What is needed is a systematic procedure. One solution is to coin new words, as the medical sciences have done. Their procedure is systematic and useful if one knows a little Greek or Latin and the rules for combining roots in these languages. Had engineering experienced its great growth at a time when schooling in Greek and Latin was still part of the college curriculum, perhaps space jargon would have followed the same path. (NASA's penchant for naming programs and vehicles after the Greek and Roman gods is, of course, a different matter altogether.) Words also can be created *de novo* within English, and there are some examples of this in space jargon (for instance, *rockoon*, a rocket launched from a balloon). Neologism, however, is no more systematic than the formation of metaphors, though it may demand less in the way of creative powers, and so it is not likely to have a larger yield of technical terms.

In official NASA dictionaries of space terms (*1*), metaphors and metonyms account for about one-eighth of the entries. In absolute terms, this is less than 100 words. Most of the remaining entries are combinations of words, put together into a particular grammatical construction, the so-called nominal compound. The solution for increasing the technical vocabulary, then, has been to resort to English syntax.

The advantages of this solution are considerable. The method is endlessly productive, since there are no limits on the constructions that may be generated by a grammatical device. It requires no exotic knowledge, since it draws only on the English lexicon and employs only rules that are general in English. Moreover, nominal compounds, however long, are always nouns and this means that they have all the maneuverability of single words. Some

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examples will make clear the type of construction a nominal compound is: *launch vehicle; escape propulsion system; battery discharger test set; separation and destruct system ordinance equipment* (*2*). These terms reveal several features worth noting about engineers' nominal compounds. Most obvious is the flexibility in length. Two words are the minimum, but there is, in theory, no upper limit. The longest nominal compound I have seen occurred in the *Congressional Record* and contained 13 words—*liquid oxygen liquid hydrogen rocket powered single stage to orbit reversible boost system*. The statement that each compound is grammatically a noun can be verified by placing the compounds in the sentence frame, "The ——— is here." Actually, the grammatical class of the compound is the class of the final word, which is always a noun. Perhaps less obvious than the grammatical class of nominal compounds is the constraint on the order in which words can appear. *Vehicle launch* is not the same thing as *launch vehicle*; nor is *discharger set battery test* the same as *battery discharger test set*. I return below to the constraint on word order, but first I must support two points already made.

One is the statement that nominal compounds are part of general English grammar, a relationship that can be simply exemplified with some familiar compounds from ordinary English. We buy from *vending machines*, park in *driveways*, and worry about *girl friends*; and we even read in Dr. Seuss of "three seater zatzit nose patting extensions" (*3*). It is not accidental that the obvious examples of nominal compounds in general English are short; the main difference between engineering jargon and general English is that long compounds are more frequent in engineering jargon. Otherwise, the two classes of compounds are the same—that is, order of words makes a difference, and the compounds are grammatically nouns.

The second point is basic to the theme of this article and so warrants elaborate treatment. It is, actually, two related points: (i) in spite of the fact that nominal compounds are general in English, they are used by engineers in response to a special pressure for technical terminology; (ii) because of this, nominal compounds are not peculiar to the space effort but appear equally often in the jargon of other engineering fields.

There is no way to measure pressure on a field to form a technical vocabulary. But it seems safe to assume that engineers are under greater pressure to do this than social scientists, who in turn experience greater pressure than literary critics or historians. Therefore, we should expect that writings by these three groups will show corresponding differences in the frequency with which nominal compounds are used, and such is the case. Samples were taken from 18 technical reports published by NASA, from six papers by psychologists, which appeared in the *Psychological Review* and the *Psychological Bulletin* (both professional journals), and from six articles from *The American Scholar*. The samples ranged in size from 3000 to 6000 words of text. Nineteen percent of all words in the NASA reports were in nominal compounds. The corresponding average for the psychologists was 8 percent, and for *The American Scholar*, 3 percent. The number of metaphors and metonyms, on the other hand, did not differ among the three samples, which perhaps indicates that this source is used to its fullest even in *The American Scholar*. Thus, most of the nominal compounds used by the engineers were probably used in response to the need for technical terms.

The average for NASA—19 percent—is duplicated almost exactly in the technical writing of other engineering fields. Twenty percent of the words in a sample of reports issued by the Operations Research Center of M.I.T. were in nominal compounds; most of the writers were electrical engineers. Similarly, 17 percent of the words in the departmental announcements of the M.I.T. departments of mechanical engineering and physics were in nominal compounds. In short, the nominal compound is used by diverse fields, apparently to meet the common need for technical terms in greater numbers than metaphors, metonyms, or neologisms can supply.

Linguistic Analysis

The basic fact about nominal compounds is that they all derive from underlying phrases, through the application of one or more grammatical rules. It is in this sense that the nominal compound is a grammatical device. *Launch vehicle*, for example, comes from the phrase *vehicle for launching*. The grammatical transformation has the effect of reversing word order and deleting the preposition and the bound morpheme *-ing*. Phrases with different structure are similarly transformed, but by different rules. *Simulation of flight*, which is a sequence of noun-preposition-noun (in contrast to noun-preposition-verb in the foregoing example) becomes the compound *flight simulation*. The rule is slightly different, but it has the same effect of reversing order and deleting the preposition. The various rules thus have similar effects; their differences consist in the type of underlying structure on which they operate.

The rules for transforming underlying phrases into compounds have been formulated in detail by the linguist R. B. Lees (*4*). I need not restate these rules here, nor take into account their complete forms. For present purposes it is sufficient to note that such rules exist and that they pair compounds with underlying phrases (*5*).

An underlying phrase can be regarded as the origin of the corresponding compound, and the process of forming nominal compounds in space jargon can be conceived of as taking place in two steps: production of the underlying phrase and transformation of the phrase into a compound by the appropriate rule. There are many rules, and so virtually any phrase can become a nominal compound. Also, as we shall see shortly, underlying phrases can be of any length, and so, therefore, can their compounds. In these two points lie the major advantages of the nominal compound as a means of increasing technical vocabulary. Given a knowledge of the rules, all that is required is a capacity to produce phrases in English.

The process is illustrated in Table 1. On the left are phrases; each row contains everything contained in the immediately preceding row plus one additional phrase or word. On the right are the corresponding compounds. We can see here how compounds grow in length, and we can also see something of the variety of phrase structures that can be transformed into nominal compounds.

Also, we can now see the basis of the constraint on the order of words in a compound. It is simply the order of words in the underlying phrase. Note that one can roughly reconstruct each phrase from the corresponding compound by reading the words of the compound in reverse order.

Table 1. Nominal compounds and corresponding phrases.

Phrase	Nominal compound
the system	the system
the system that controls	the control system
the system that controls attitude	the attitude control system
the system that controls attitude of the ship	the ship attitude control system
the system that controls attitude of the ship by ejecting	the ejection ship attitude control system
the system that controls attitude of the ship by ejecting gas	the gas ejection ship attitude control system
the system that controls attitude of the ship by ejecting gas through nozzles	the nozzle gas ejection ship attitude control system

One way to demonstrate that compounds correspond to phrases is to show that they can be bracketed in the same way. Bracketing is grammatical parsing done with brackets; it is a notation showing where the constituents of the compound or phrase are. (In the present case, contrary to usual practice, the brackets have been drawn above and below the string of words.) For the compound of Table 1 we get,

The nozzle gas ejection
ship attitude control system,

which corresponds exactly to

The system that controls
attitude of the ship
by ejecting gas through nozzles.

Most of the constituents marked off in this fashion overlap. (One pair of constituents does not, which is the reason why row 5 of Table 1 seems incomplete; in fact, it is not complete, since one constituent is only half represented.) However, not all compounds or phases have overlapping constituents. For phrases of a different structure, the relative positions of the brackets are different. For example, the pseudo-space phrase

a program that orbits astronauts,
makes modules, and embarrasses Russians

becomes the compound

a Russian embarrassing module making
astronaut orbiting program

As the bracketing shows, no constituents overlap. The cases of overlapping and nonoverlapping constituents, plus combinations of the two, appear to encompass all the situations in which long phrases can be transformed into single nominal compounds. Other phrase structures, such as the "self-embedding construction," in which a sentence is constructed like an onion (for example, "The race that the car that the people whom the man called sold won was held last summer"), cannot be transformed into nominal compounds. With allowable phrase structures, however, long compounds can be generated from long phrases through successive application of Lees's rules. Each rule produces only a two-word compound, but by applying the rules in a left-to-right direction throughout the phrase, one produces a right-to-left growth of the compound. The result is an orderly and predictable dependence of compounds on underlying phrases, a relation that is sufficient basis for use of the nominal compound as a source of technical terminology.

Psycholinguistic Implications

In the actual use of nominal compounds as technical terms, more is involved than the application of Lees's rules of transformation. One might suppose that the rules for forming compounds would work in two directions, from underlying phrase to compound and back again. In theory, of course, they do; it is always possible to retransform a compound into a phrase. But transformations in the two directions are not equally determined. Whereas transformation of a phrase is unique, retransformation of a compound is often ambiguous. *Mission suitability*, for example, could derive from either "suitability *for* the mission" or "suitability *of* the mission," which are quite different things. To NASA engineers, the term has the former meaning. Similarly, *time critical equipment* could mean "equipment for which there is a critical time [during which it is usable]" or "equipment for which there is a critical time [for performing a function]". Again, the former is the correct meaning.

Although such ambiguities exist, NASA engineers seem unaware of them. I interviewed four engineers at the Marshall Space Flight Center in Huntsville, Alabama; all were actively engaged in the design or testing of apparatus used in the Apollo program. They were alert and cooperative informants, but none was aware of ambiguities of the sort just mentioned. In view of the fact that nominal compounds are *constructed*, this is rather remarkable. One explanation is that these engineers had "recoded" certain of the nominal compounds into single units, quite as if they were simple nouns. Possibly, such recoding is due to a suspension of the process of transformation, and tends to occur in the case of nominal compounds that are used frequently. Presumably the status of these recoded compounds is similar to that of the nominal compounds of ordinary English. *Driveway* means "way *for* driving," but "way *of* driving" is equally possible. The fact seems to be that we do not disassemble *driveway* in order to understand it, and so we are, like the engineers, unaware of the ambiguity.

If we make the assumption that frequently occurring nominal compounds in engineering jargon are understood as unified nouns, we can see that it is for the encoder of terms, not the decoder, that this grammatical device is advantageous. Moreover, since an established nominal compound that is understood as a unit probably is produced as a unit as well, the advantages are not primarily for every encoder, but for the encoder who is producing a new term. The result is that the nominal compound is a device that mainly benefits the "culture," guaranteeing that new technical terms will be available when needed.

That frequently occurring nominal compounds can be recoded does not mean that the rules for forming nominal compounds are linguistic fictions. On the contrary, they conform to actual psychological processes. When asked to "unravel" nominal compounds, the engineers interviewed at Huntsville produced phrases in which the words of the compound appeared in reverse order. And, conversely, when the engineers were asked to create nominal compounds to go with definitions (which were unfamiliar to them but taken from a NASA dictionary), they selected two or more words in the definition, reversed their order, and placed them into a compound. Usually, in this latter experiment, the term the engineers created was not the term defined in the dictionary. But that does not alter the conclusion that, psychologically as well as linguistically, nominal compounds are transformed phrases.

Many people suspect that engineers use the nominal compound because of a careless lack of concern for the requirements of style. This seems to be a general opinion among nontechnical readers of engineering prose. It is an opinion, however, which overlooks the fact that nominal compounds are transformations, and so require the user to go at least one step beyond formulating an underlying phrase. Consider the following data. The proportion of all words in nominal compounds has already been given as 19 percent for several NASA technical reports. For some of the writers of these reports, samples of spoken language also were available (from written and oral testimony before a congressional committee). If the nominal compound is overused through carelessness, it should occur more often when an individual is speaking extempore than when he is writing. However, this is not the case; the nominal compound is a literary phenomenon.

Compared to the figure of 19 percent for written materials, only 7 percent of spoken words are in nominal compounds. The pressure of spontaneous speech thus has an effect quite opposite from the effect the hypothesis of carelessness would predict. Evidently, use of the nominal compound in technical writing reflects literary care, not lack of it. The nominal compounds that are used in speech are short and among the most common. In all probability, they are recoded compounds. If that is the case, the 12 percent comprised of compounds used in written language but not in speech would for the most part be newly created terms. There is psychological evidence (*6*) that speech containing many transformations is more difficult to understand than speech containing few transformations. Probably there is a similar difference in difficulty when speech is produced, so the nominal compound is used less frequently in spoken than in written language. It simply takes too much time and causes too much confusion to transform phrases as frequently when one is speaking as one does when writing.

Influence of Space Jargon

There are at least two ways in which space jargon may influence the general language. One is through what may be called *specific* influence. In this case, a particular term passes into nontechnical language. There are numerous familiar examples: *countdown, astronaut, space probe*, and so on. Metaphors, metonyms, neologisms, and nominal compounds—all might be introduced into the general language as specific terms. The basis of specific influence is some knowledge, on the part of the speaker or writer, of the hardware or concept that the technical term names. Thus, specific influence is limited by the extent of the infusion of technical knowledge, but, by the same token, terms carried into the language through specific influence do not importantly change meaning in their passage from jargon to general language.

However, some of these terms appear to undergo a further development once they have been taken into the general language. For example, one hears people speak of starting something from a "launching pad of . . .," by which they mean a "basis of. . . ." This is a metaphorical use of the space term *pad*. Some of the adopted terms that change in this way are already metaphors in space jargon, being adaptations of ordinary English words. *Pad* is an example. These new metaphors, then, actually are attachments of new meanings to old words, a process known to linguists as polysemy. Specific influence, therefore, can have two rather different effects. One derives from the simple introduction of technical terms; the consequences of this should be narrow for the general language. The other derives from the attachment of new meanings to old words, and it has more devastating possibilities. Polysemy is held to be a major force for change in language, and, through it, terms such as *pad* could conceivably lose their present meaning: our descendants may talk about the pad of our democracy being free speech.

Not all words that pass as "space speak" come from space technology. Indeed, some of the most popular specimens are spurious, having been invented by newsmen. Among the most notable of these are *A-OK, blast off*, and *spin off*. Nonetheless, many such words are examples of polysemy, and so are potential sources of change of meaning.

In contrast to specific influence, there is a second, more *generic* influence. In this case, elaborate use of the grammatical device of the nominal compound itself is adopted. Generic influence in no way depends on technical knowledge; it consists simply of extensive use of a construction already available in the general language. One way in which generic influence is mediated was suggested by some of the engineers whom I interviewed at Huntsville. On occasion, they said, engineers will deliberately overuse the nominal compound in order to impress their auditors. Apparently the nominal compound has about it an aura of technical sophistication. Such exploitation of the nominal compound could work also in the opposite direction, in that nontechnologists who desire to resemble technologists can use the nominal compound as a kind of poor man's engineering jargon. This would be an example of generic influence.

These considerations suggest computation of a measure, called here the "pretension index," for analyzing samples of prose for evidence of generic influence. The name pretension index is used to indicate that, by overusing the nominal compound, one can pretend to possess a degree of technical knowledgeability that, in fact, one does not have. There are two senses in which the nominal compound could be "overused," and the pretension index might measure either one of them. Overuse could be taken to mean simply increased frequency of use of these compounds. However, such an increase could occur simply because the content of a passage required it, and this would have nothing to do with generic influence. Because of this possibility, the pretension index measures overuse in the second sense—an increased use of the number of long compounds relative to the number of short compounds. The idea is that unnecessary use of the nominal compound would favor both increased frequency and increased length, but that where technical content requires unusually frequent use of some nominal compounds in a given passage, it would not ordinarily require, at the same time, an increase in their length. Greater length can come only from (i) a need to make technical terms more specific or from (ii) use of the nominal compound without regard to technical terminology.

The pretension index is computed

from the number of compounds of length 2, 3, 4, 5, . . . words that occur in a sample of prose. There is a simple relation between length and frequency, known as Zipf's law, that holds for a great variety of textual material. Zipf's law states that the logarithm of frequency and the logarithm of length are negatively related to each other by a straight line. In brief, the law states that the frequency of words (or compounds) is proportional to their shortness. The shorter the word or compound, the more frequent its occurrence. The slope of the line relating frequency and length, the "Zipf slope," depends on the relative number of long and short words or compounds. The pretension index is based on the "Zipf slope," but not directly, for it is necessary also to make some reference to a standard. An appropriate standard is the "Zipf slope" for the entries in a dictionary of space terminology. Such dictionaries contain only technical terms, and thus provide an estimate of the relative numbers of long and short compounds in the true technical vocabulary. The pretension index for a sample of speech, then, is computed by dividing the "Zipf slope" of the standard by the measured "Zipf slope" of the sample. The higher the index, the more "pretentious" the sample of speech.

Equipped with an index, we can now see whether there is any evidence for generic influence of space jargon. Pretension indices have been computed for samples of writing by NASA engineers (the same material that was used in the study cited above); for samples of spoken material by NASA personnel (oral testimony before a congressional committee); for samples of spoken material by some members of Congress; and for samples of writing from a popular magazine on space technology. In these computations NASA represents the engineering profession; the Congressmen and the space magazine represent laymen who deal a good bit with space technology. The results are given in Table 2.

Table 2. Pretension indices for several samples of speech.

Sample	Pretension index
NASA, written	1.00
NASA, spoken	0.79
Magazine on space technology, written	1.46
Congress, spoken	0.94

The proper comparisons here are within modes of communication—written-to-written and spoken-to-spoken. Clearly, the space magazine uses relatively too many long compounds for all of them to be true technical terms. Since the pretension index is based on logarithms, small numerical differences reflect large differences in length of the compounds; expressed as percentages, these data are much more impressive. In the space magazine there are 220 percent more five-word compounds than there are in the NASA written reports, and 300 percent more six-word compounds. There is no reason to suppose that only the long compounds in the space magazine are nontechnical; no doubt many of the short compounds also result from generic influence.

The slopes for the two oral samples are both lower than those for the written samples—an effect that derives, in all probability, from the need to avoid complicated transformations in spontaneous speech. Nonetheless, Congressmen have an index nearly as high when speaking as NASA engineers have when writing, and possibly this too reflects generic influence.

Generic influence, of course, need not be limited to the nonengineer who attempts to appear knowledgeable about space technology. The nominal compound can be a source of borrowed dignity for any professional jargon. On the other hand, it would be a mistake to assume that every extensive use of the nominal compound by nonengineers is a case of generic influence. Other professional people may turn to it for the same reasons that engineers do, for technical terms. I know of no way to distinguish generic influence throughout the language from independent discovery of the nominal compound as a form of professional jargon. However, those who dread the influence of engineering jargon may be heartened to learn that newspapers, outside their science columns, show little indication of adopting the nominal compound.

Acronyms

As already indicated, Zipf's law asserts that the shorter compounds are the more frequent. The relation is often interpreted as showing causality: words (or compounds) become shorter because they are more frequently used. Indeed, Zipf concluded from his law that language users follow a principle of least effort. Whether or not Zipf's theory is correct, his law—which is a purely mathematical statement—implies that particular compounds should become shorter as their frequency of use increases. It is clear that such a shortening does take place in the case of individual words, as the erosion of *television* to *video* to *TV* illustrates. However, it is equally clear that compounds cannot be shortened in this way, for the reason that they have grammatical structure. When a word is shortened, the abbreviation appears to be made almost arbitrarily; it must remain pronounceable, but there are no other requirements. In England, for example, *television* has changed to *telly*. Comparable freedom does not exist with compounds. One cannot shorten *escape propulsion system* to *escape system, escape propulsion*, or *propulsion system* without changing the original meaning. The abbreviations correspond to new underlying phrases that are not identical with the original phrase. The solution to this problem, of course, is the acronym. Thus, *escape propulsion system* becomes *EPS*, while *propulsion system, escape system*, and *escape propulsion* become *PS, ES*, and *EP*, respectively. The original structural distinctions among the compounds are all represented among the acronyms. I suspect that most cases of "acronyming" can be explained as efforts to conform to Zipf's law without changing meaning at the same time. However, not all acronyms result from increased frequency of use of compounds. In some cases the sequence apparently is reversed: the acronym is devised first, then a compound is found to fit it. In these cases the acronym often spells a word whose meaning is somehow relevant to the meaning of the compound. This is a literary game, not the outcome of the natural linguistic development implied by Zipf's law. One such playful acronym is *EGADS*, which names the system used to destroy a malfunctioning missile after it has been launched, and "goes" with the compound *electronic ground automatic destruct sequencer*.

It is not possible, obviously, to disassemble an acronym into a kernel phrase. But, since frequently used compounds tend to be recoded and thus are not disassembled anyway, nothing is lost by reducing these compounds to acronyms. The ultimate outcome of compounding followed by "acronyming" is the creation of new vocabulary. In effect, acronyms are new words. However, they are words manufactured according to definite principles and so can be coined in abundance.

A Concluding Remark

Professional jargon is a topic that stands at the intersection of several academic fields. Sociology, anthropology, linguistics, and psychology, at least, can find something of interest in it. The emphasis here has been on the psycholinguistic aspects, not because they are the most notable in the study of jargon, but, on the contrary, because they have been the most neglected. However, it is not likely that psychologists or linguists will be entirely satisfied with the results. The psychologist will find the data scanty; the linguist will find the statement of rules informal. Both will be correct, for this psycholinguistic study of jargon should be regarded as preliminary. The purpose here has been merely to indicate some interesting lines of inquiry.

But until further work has been done, we can conclude that the following statement is probably true: space speak is an engineering technology concept expression manuscript sentence grammar device.

References and Notes

1. "Short Glossary of Space Terms," *NASA (Nat. Aeron. Space Admin.) Publ. SP-1* (1962); "Apollo Terminology," *NASA (Nat. Aeron. Space Admin.) Publ. SP-6001* (1963).
2. *Destruct* is another neologism, which in many cases replaces the verb *destroy*; the reason for the neologism, I was told, is to avoid the warlike overtones of *destroy*.
3. T. S. Geisel (Dr. Seuss), *On Beyond Zebra!* (Random House, New York, 1955); I am indebted to Nobuko McNeill for bringing this example to my attention.
4. R. B. Lees, *Intern. J. Amer. Linguistics* **26**, No. 3 (July 1960).
5. Actually, transformations do not operate on phrases, but operate on the abstract structure out of which phrases are built. The distinction is critical in most discussions of syntax. In the present case, however, the reader will not be seriously misled by thinking of phrases rather than structures. It should be borne in mind, nonetheless, that the term *underlying phrase* is really a loose figure of speech. For a complete discussion of the relation between phrases and underlying syntactic structures, see N. Chomsky, *Aspects of the Theory of Syntax* (M.I.T. Press, Cambridge, Mass., 1965).
6. G. A. Miller, *Amer. Psychologist* **17**, 748 (1962).

7. Preparation of this article was supported in part by a grant (No. NsG-253-62) from the National Aeronautics and Space Administration to the American Academy of Arts and Sciences, Committee on Space, and in part by a grant (No. 5-TI-GM-1011-02) from the National Institutes of Health to Harvard University, Center for Cognitive Studies. Final preparation of the article was supported in part by a grant (No. 1PO1 HD01368-01) from the National Institute of Child Health and Human Development to the Project on Language Development, University of Michigan, and in part by a contract (No. OE-5-14-036) between the U.S. Office of Education and the Center for Research on Language and Language Behavior, University of Michigan.

Continuing Education for Engineers

Fundamental questions surrounding this new challenge to the engineering profession are discussed.

Harold A. Foecke

I am convinced that continuing education is *the* educational challenge of the future, that most of what we have been accustomed to regard as education must be judged in relation to continuing education, and that a frontal attack on the problems of continuing education would yield as a by-product benefits of great value to all "pre-continuing education" (if I may use such a term).

In posing and discussing some of the fundamental questions surrounding the challenge of continuing education for engineers, I present my views of both the specific problem facing the engineer ing profession and the larger problem of which it is a part. Needless to say, a paper of reasonable length cannot deal exhaustively with a subject of this scope and complexity. In trying to focus on basic issues and questions, I rely upon the existing literature to supply background details to those who need them.

Is the Problem Real?

A short time ago a prominent engineering educator told me that he felt that much of the current discussion about continuing education for engineers is just a transient tempest in a teapot —a fashionable subject which will subside to the general noise level as soon as some other topic rockets into prominence. From my experience I believe that many thoughtful people share this view. Consequently, numerous as the discussions of continuing education for engineers have been, we probably should begin by asking, "Is the problem real?"

I feel that some aspects of the problem may have been exaggerated and that we may be blithely proceeding on the basis of some untested assumptions and "myth-information." Fear strikes the heart of the engineer when he hears someone pronounce (but not prove) that the "half-life of an engineering education" is a certain number of years—5, 7, or 10. We stand in awe of the so-called "information explosion," sometimes not appreciating that most measures of this are in terms of quantities of paper, without reference to the decreasing number of significant ideas per printed page. Fuel was added to the concern several years ago when changes in the patterns of federal defense spending caused the dismissal of significant numbers of engineers in various metropolitan areas, the assumption being that

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