provide improved characters on the upward-writing slate. This new paper makes it possible for a letter or number to be embossed on the working side of the paper without reversing the characters.

The polyethylene paper No. 300 is available in sheets sized 8½ by 11 inches (1 inch = 2.5 cm). Preformed raised guidelines, approximately ¾ inch apart, are recommended to keep rows even. This new paper with guidelines has been designated No. 310 (*5*). A jumbo or oversize ball-point pen gives the best embossed markings, but a somewhat blunt-pointed pencil may be substituted; a very hard writing surface gives the best results. The impressions must be made with added pressure to ensure the embossing effect, which is enhanced by rubbing the finger over the area marked by the pen. Mastering the technique of pressing down on the polyethylene paper takes only a few practice trials. The best type of letter or number is a simply made one, without extra loops or frills (Fig. 1). The embossed letters have a mean height above the page surface of approximately 0.016 inch, but the height varies some with the individual and with the pressure applied. This value is somewhat less than the usual height of Braille symbols, but few of our observers have experienced difficulty with this characteristic. The pen or pencil gives color to the impression, which is an added aid to the partially sighted as well as to the sighted correspondent (Fig. 1).

"The Sewell Raised Line Drawing Kit" (*6*) also produces raised-line characters. This kit comprises a special rubber-covered drawing board, a ball-point pen with colorless lubricant (no ink), and a type of transparent writing material. However, the polyethylene paper described here represents an improvement, because only a special paper is required, and the letters are visible and can also be felt.

Approximately 50 subjects have been tested. Twenty of these were totally blind or partially sighted; 30 were normally sighted subjects who covered their eyes during the test. The subjects were all presented sample numbers, letters, words, and sentences, but they could not see the material before the test. The only comment made by the experimenter was that the number, letter, or word was about ½ inch high and printed in a very simple manner. In less than a minute, virtually all the subjects were able to discern the first number or letter they were evaluating with their fingertips. One subject was able to read an entire page in about 3 minutes.

The new polyethylene paper resolves many problems in communicating with the multihandicapped, such as the person who is both deaf and blind. A newly blinded person can almost immediately write numbers and letters he has always known. With the use of this new paper, the sighted and nonsighted can readily communicate. There is only a brief learning period for the newly blinded person; there is no learning of a difficult system for the sighted friend or family member; and there is no need for any gadget or appliance coupled with the paper. The new, raised-line polyethylene paper and an ordinary jumbo ball-point pen or blunt pencil are all that is necessary to obtain the desired effect. Interestingly, a small number of diabetic patients, who were sighted in youth, learned Braille after the onset of blindness, and had lost much tactile sensitivity (and hence were having difficulty with Braille), were able to read the Arabic letters and numbers presented to them with relative ease.

RUTH L. BARR

53 Webster Acres,
Webster Groves, Missouri 63119

References and Notes

1. R. L. Barr, *New Outlook for the Blind* **62**, 138 (May 1968).
2. ———, *Amer. J. Occup. Therapy* **23**, 439, abstr. (Sept.–Oct. 1969).
3. "Barr Slate Available," *New Outlook for the Blind* **63** (5), 141 (May 1969).
4. Polyethylene Paper No. 500 from Nu-Vu Products Company, 45 East Lockwood, Webster Groves, Missouri 63119.
5. Polyethylene Paper Nos. 300 and 310 from Nu-Vu Products Company.
6. "The Sewel Raised Line Drawing Kit," U.S. Patent No. 2,616,158, is available from the American Foundation for the Blind.

26 February 1970

Fetal Movement: Development and Time Course

Abstract. *Prenatal behavior develops in three phases: early rates, acceleration and maintenance, and deceleration to birth. Fetal activity occurs as discrete movements, bursts of activity, and prolonged activity. Four-hour samples were most representative of the daily rates of movement.*

The time course of embryonic development has been determined but the development of prenatal behavior has not been adequately described for either the normal or defective fetus, largely because adequate techniques for recording fetal behavior have been lacking. Fetal development has typically been evaluated from the mother's report of fetal activity (*1, 2*). It is

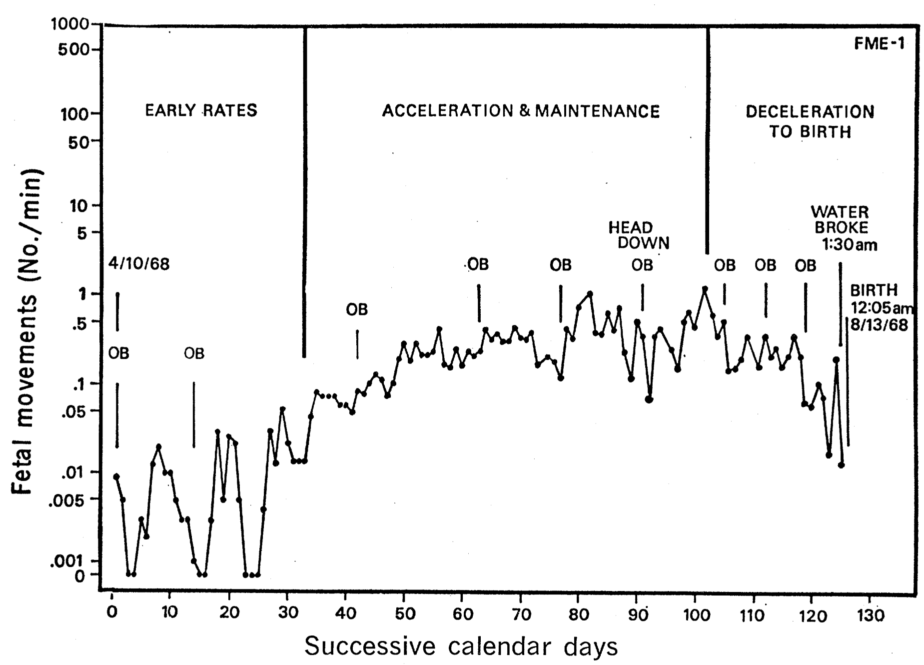

Fig. 1. Graphic presentation of the time course of fetal movements during prenatal development.

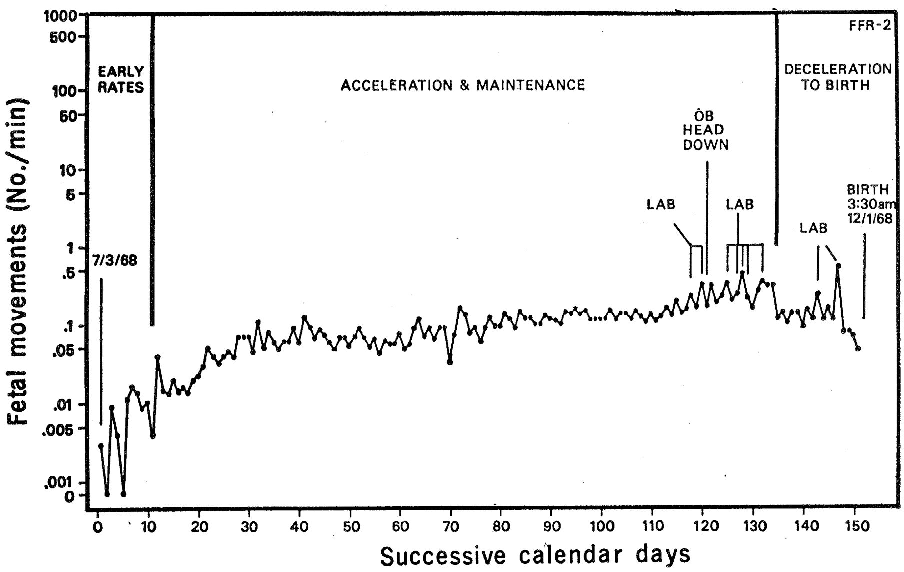

Fig. 2. Graphic presentation of the time course of fetal movements during prenatal development.

difficult to summarize findings from such records because of the great variation in (i) recording methods used, (ii) the time period in fetal development during which the records were taken, (iii) the duration of the recording periods, (iv) the frequency of recordings taken, (v) the datum recorded, and (vi) the conditions under which behavior was recorded. We have devised a method for continuously recording fetal movements during normal activities of the mother and during laboratory visits. With this method, we have been able to determine the time course of changes in fetal movement, a measure of behavioral development in the human fetus.

Eight pregnant women were asked to record every fetal kick felt during the waking day, from the first day a kick was noticed to the time of birth.

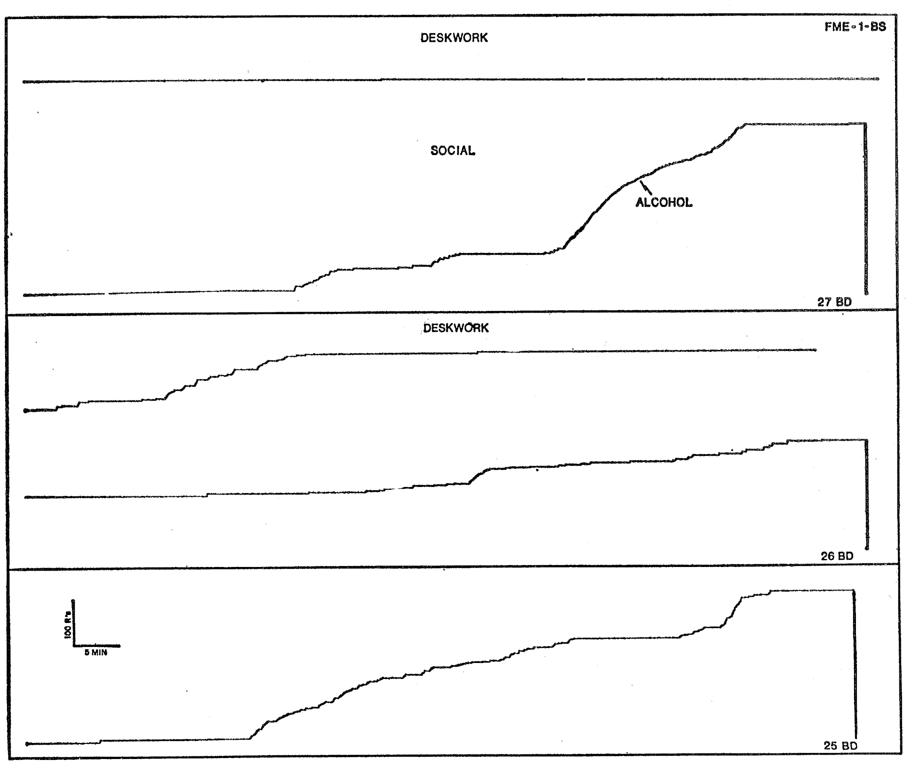

Fig. 3. Records of patterns of fetal movement within a day in relation to changes in the mother's activity. (Records read left to right.)

Kicks were recorded every 4 hours. The totals were divided by the appropriate time to obtain the daily rates. The mother's environmental conditions and activity, the number of cigarettes smoked, and the alcohol consumed were also recorded daily for most mothers.

Daily rates and rates for shorter periods were plotted on separate charts to permit their comparison. Automatic records were also taken in the home and in the laboratory by having the women depress a hand switch which stepped a recording pen a discrete distance up a paper moving at a constant speed. From the slope and distribution of counts one can determine the rate of responding (*3*).

Fetal movement appears to develop in three stages (Figs. 1 and 2). In the early stage, rates of movement generally vary between 0 and 1 or 1.5 movements per 100 minutes. For about a week the rate is maintained at 1 or more per 100 minutes. Then the rate accelerates and is maintained between 2 and 10 per 10 minutes until the fetus changes position. The rates then become more variable and decrease until birth. All eight charts reflect the same general pattern despite variations in absolute rates.

Each record in Fig. 3 provides information regarding the effect of a mother's activity on fetal movements. Fetal activity occurs as discrete movements, bursts of activity, and prolonged activity. Four records were taken while the woman worked at her desk. Another, taken during a social activity when the woman ingested some alcohol, is characterized by prolonged fetal movement.

Our method of recording reflects patterns of movement and changes in the frequency of movements. Bursts of activity and prolonged activity have not been described before. Previously different types of fetal movements or the percentage of time when the fetus was active have been recorded during the last few months of pregnancy (*2*, *4*). Between two and four different types of movements such as kicks, squirms, ripples, and hiccups or quickening movements, slow movements, and rhythmic movements were reported. We have focused on the record of activity rather than on the type of movement, and it is not clear how these earlier records compare with our records.

Since most previous studies used samples taken over a short time, we compared rates of fetal movement recorded automatically with the 4-hour samples and daily rates. In all cases, samples ranging from 30 to 200 minutes were not representative of the daily rates. The 4-hour samples were closest to the daily rates. There did not appear to be any systematic relationship between the mother's activity and changes in daily rates, 4-hour rates, or automatically recorded rates of fetal movement.

Because the mother's report was commonly used in earlier studies, we assessed the accuracy of such reporting by having each mother estimate how many movements had occurred during automatic recording either at home or in the laboratory. Even the most accurate mother had greater than 10 percent error in 57 percent of her estimates. The similarity in behavior of all fetuses is evidence that a direct and continuous account of fetal development is possible with our method.

DIANE DEA. EDWARDS
Department of Psychology, University of Missouri, Kansas City
JOSEPH S. EDWARDS
Bureau of Child Research, University of Kansas Medical Center, Kansas City

References and Notes

1. G. R. Schmiedler, *Child Develop.* **12**, 63 (1941); L. W. Sontag, *Amer. J. Obstet. Gynecol.* **42**, 996 (1941).
2. J. Bernard, *Child Develop.* **35**, 1243 (1964); C. E. Walters, *ibid.*, p. 1249.
3. C. B. Ferster and B. F. Skinner, *Schedules of Reinforcement* (Appleton-Century-Crofts, New York, 1957).
4. C. E. Walters, *Child Develop.* **36**, 801 (1965); H. Newberry, *J. Comp. Psychol.* **32**, 521, (1941); T. W. Richards, H. Newberry, R. Fallagatter, *Child Develop.* **9**, 69 (1938).
5. We thank Betty L. Walls and Dr. B. J. Masterson for assistance.

18 May 1970

Economic Meaning of a Labor Shortage

Keynes pointed out that in a laissez-faire economy geared to a high level of investment spending, population growth, via its effect on investment, might be an important factor in maintaining prosperity. He also showed, however, that fiscal and monetary policy could be used to counteract fluctuations in private investment and thus maintain a generally high level of income and employment whatever might be happening to population growth.

Now a new concern is being voiced: Without population growth, crippling labor shortages may develop. According to Boffey's report (*1*) on Japan's Population Problems Inquiry Council, "the recommendations are aimed at alleviating some potentially serious economic and social problems that are related, at least in part, to Japan's success in curbing its population growth. One such problem is a worsening labor shortage that threatens to undermine Japan's 'economic miracle' . . ." It might seem that the relation between population growth and labor shortage is a simple one: Rapid growth assures an abundance of labor; slow—or negative—growth creates a shortage. Actually, the relation is more complicated.

In the "short-run," Keynesian sense, a shortage—or surplus—of labor is a result of the relation between aggregate demand and aggregate supply in the economy. Since aggregate demand can be altered by appropriate fiscal and monetary measures, it follows that we can always create, or relieve, a labor shortage. Recent U.S. history provides an interesting example: From 1957 to 1963 the growth of the labor force was relatively slow (800,000 per year), while labor was relatively abundant (unemployment averaged 6 percent). Since 1965, labor force growth has been much larger (1,600,000 per year), but until quite recently the labor market has been unusually tight (3.7 percent average unemployment). Now, in the interest of combating inflation, the Administration is using fiscal and monetary policy to create a bit more of a labor surplus.

"Labor shortage" can also be used in a "long-run," or structural, sense. Instead of the relation between aggregate demand and aggregate supply, what is involved in this concept is the relation between the supply of labor and the supply of capital. If capital is growing rapidly, while labor is growing slowly, or not at all, labor will be scarce and wages will rise more rapidly than would otherwise be the case. It should be obvious that in this sense a shortage of labor is the same as an abundance of capital. Surely no democratic government, if it understood clearly what it was doing, would attempt to keep capital from becoming more abundant relative to labor.

That a shortage of labor is nonetheless looked on as a threat to a nation's economic health is the result no doubt of a failure to distinguish between per capita and overall expansion. It is true, of course, that Japan's total gross national product (GNP) can expand faster if the labor force grows than if it does not. But aside from military considerations—themselves of dubious validity in a nuclear age—the objective of policy should be expansion of per capita not of total GNP. And per capita GNP will be higher, generally speaking, the larger the amount of capital there is for each person to work with. The case for considering per capita rather than total GNP is especially strong in a country like Japan where overcrowding is already acute and where the negative effects of expansion on the quality of life, which are not included in the conventional measure of GNP, are in consequence especially large.

ALAN R. SWEEZY
Department of Economics, California Institute of Technology, Pasadena

Reference

1. P. Boffey, *Science* **167**, 960 (1970).
23 March 1970

Interference in the Lowry Method for Protein Determination

In view of the widespread use of the Lowry method for determination of proteins (*1*) and the increasing popularity of Good's buffers (*2*), we feel that certain incompatibilities between the two should be recorded. In the Lowry reaction, some of the commercially available buffers and some analogous compounds give color in the absence of protein; among them are (*3*) HEPPS, HEPES, and Bicine, and to a much lesser degree BES, PIPES, ADA, ACES, MOPS, glycine amide, TAPS, and CAPS. This color has the same absorption spectrum as the color produced by protein. Five micromoles of HEPES is equivalent to 300 micrograms of bovine plasma albumin.

Some of the buffers, in addition to giving color, prevent the formation of the normal amount of color by proteins, for example ADA, Tris, Tricine, and TAPS. The buffers MES (pK_a at