for it, and would provide a diploma and job for those who are not degree-oriented. Tradesmen, mechanics, engineers, and placement and vocational counselors from industry should be among the visiting faculty. Instruction in automotive mechanics, maintenance of refrigeration, laundry and electronic equipment, radio, and aircraft belongs in such a curriculum. Also the building trade skills and laboratory techniques—all occupations found in any given community—should be taught. In addition, such vocational students would require a core program aimed at improving their academic skills in reading, comprehension, writing, and general communication.

Community surveys of labor needs administered periodically by the university and its technical and mechanical institute should determine the emphasis to be placed on instruction in various occupations. Labor leaders could serve as advisers in curriculum planning and placement. The mechanic or skilled craftsman of the future should not only have a "college image," but also should fill a basic need in the community as a most useful citizen instead of a dropout.

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Automobile Exhaust Standards

In the "News and Comment" article by Andrew Jamison (5 July, p. 27), the stated 1970 exhaust emission standards recently set by the Department of Health, Education, and Welfare are incorrect. The correct standards are 2.2 grams per vehicle mile for hydrocarbons, 23 grams per vehicle mile for carbon monoxide, and no stated standard for oxides of nitrogen (*1*).

In addition, in 1971 a standard for fuel evaporative emissions will be in effect and hydrocarbons from this source shall not exceed 6 grams per test. Jamison has stated 1968–69 standards for the new 1970 standards, which are considerably more severe, especially for the larger displacement engines.

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Reference

1. *Federal Register* **33**, 8304 (1968).

Fight—or Ultimately Die

Ashley Montagu in his letter (6 Sept.) cites the Pueblo Indians, the Eskimo, the Bushmen, the Ifaluk, the Australian aborigines, and the Pygmies as having no internal urge to fight. While these peoples are to be admired for their tenacity in surviving in the inhospitable environments to which they have withdrawn, they can hardly be classed as successful or developing societies, and their futures are dark.

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Computer and Console: Costs and Convenience

I agree with much of M. V. Mathews' article, "Choosing a scientific computer for service" (5 July, p. 23), particularly the "permanent computer" concept, but his comments on time sharing do not seem to apply to my own experiences in using time-sharing consoles for scientific computation. At commercial time-sharing service rates, I have found time sharing, over the past 3 years, to be a very inexpensive way of using a computer to help solve technical problems.

My console and phone line rents for about $90 per month from the telephone company. The time-sharing service costs a little over $10 per hour of actual use with a minimum charge of $100 per month. This adds up to a basic cost of about $200 per month, plus about $10 per hour for more than 10 hours per month use. The only way we could get a console up to the "$2000 to $3000 per month" mentioned by Mathews would be to provide only one console for many people so that the console would be busy *all* the time, 200 hours per month. We did this in the early days, but found that time sharing is of little value if the user has to wait half a day to get to the console. We also found this waiting time is a lot more costly than idle console time.

The people who use our time-sharing consoles cost our company about $12 per hour. An idle console costs about 50 cents per hour. A simple theory of queueing analysis that minimizes the cost of waiting people plus the cost of waiting consoles shows that for a practical minimum total cost our consoles should be in use about 10 percent of the time (idle consoles are much cheaper than waiting people). For minimum total cost, the consoles should be ready and waiting for the people. The same analysis applied to people using a computer shows that for minimum total cost the people should be ready and waiting to use the computer. Here, waiting people are much less expensive than an idle computer.

A $90-per-month phone line and console optimally used 10 percent of the time, 18 hours per month, at $10 per hour of use, costs a total of $270 per month. This seems to be a more realistic "sample cost of commercial time-sharing service" than $2000 to $3000 per console per month estimated by Mathews. The total cost of a console and service is 10 to 15 percent of the cost of *one* of the people using it.

For some of the larger jobs that require from 1 to 2 months of my time to analyze the problem, program and debug it, and get results—I have found little difference in cost, my time, or elapsed time between doing the job on time sharing or on the batch computer downstairs. The bottleneck on these relatively large jobs appears to be me, and not the computer. This experience seems to agree with Mathews' statement that consoles have little to offer in programs which are complex, large, and long.

But I encounter many equally important technical problems which take only an hour to a day of my time to solve with time sharing. These may require a new short program or a modification of an old large program. In pretime-sharing days I could not use a computer to help solve these smaller problems. I've never been able to get any job programmed, debugged, and run in less than a week or two using a batch computer, even with fairly good priorities on computer time. Here the computer, or rather getting to it, appears to be the bottleneck.

I could rarely afford to wait a week or two to get a problem solved, so I would have to use some faster, but less adequate, noncomputer solution method. With time sharing, I can get an hour's work done in an hour of elapsed time and get on with the next step of an overall job. I couldn't do this before, so I feel that time sharing is inexpensive and often the only practical way of using computers to help solve many technical problems.

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