18 March 1977, Volume 195, Number 4283 **SCIENCE**

Electronics Revolution

Although destined to be of enormous importance, the electronics revolution has proceeded with comparatively little notice. In recent years, public attention has been more closely focused on such matters as population, energy, food and nutrition, and materials. Correspondingly, *Science* has devoted considerable space to these topics in special issues and compendia. It has become clear to us that electronics merits comparable treatment. Individual applications, taken separately, may not be of crucial importance, but the summation is. Beyond that, an extrapolation of current trends points to an even greater impact.

The electronics revolution is now extremely dynamic. Costs of important components such as large-scale integrated circuits and devices based on them have been dropping sharply; at the same time, their effectiveness has been increasing. Major changes are occurring in a year or two in contrast to a time scale of a decade found in other spheres of technology. A steady stream of new products has been emerging, some of which are tapping mass markets. Other products are changing the ways in which business, banking, and industry are conducted.

The dynamism of electronics is in sharp contrast to the slow-moving, static, or deteriorating situations encountered in energy, food and nutrition, and materials. The days of easy exploitation of natural resources have passed, and adjustments to scarcities and to the use of substitutes will be slow and difficult.

At this time of facing many limits to physical growth, it is pleasant to note that a major sphere of activities based on the use of organized knowledge is thriving. Moreover, although electronics of itself will not furnish our food, clothing, and shelter, it will help us to be more effective in the research, development, and implementation of methods leading to the meeting of these and other human needs.

The industrial revolution and the electronics revolution differ in the type of power that they provide. In primitive societies humans could employ self-generated energy of 75 watts. Today the typical American uses an average of about 10 kilowatts. On an intellectual front primitive humans could draw on folklore. Modern society has available a tremendous and increasing reservoir of scientific and technical knowledge. The electronics revolution is making that knowledge more readily available, extending intellectual powers often by many orders of magnitude while facilitating greatly the accumulation of more knowledge.

The Industrial Revolution has had an enormous impact on the shape of the economy, giving rise in recent years to the mobile society. Widespread ownership of automobiles gave individuals an added sense of dignity and an agreeable feeling of control of power. As liquid fuel becomes scarce and expensive, the average individual may no longer be able to enjoy such power. As the vigor of the industrial revolution fades, the electronics revolution will provide impetus for the reshaping of society in new directions. At the same time it will provide at least partial substitutes for the sense of power that the automobile has provided: one of these will be a feeling of enhanced intellectual power.

It is premature to predict the directions that society will take in response to the electronics revolution. Rather we have sought to provide a snapshot of the revolution itself. The authors in this issue have included sufficient historical background and projections of the future to lend a time perspective to the picture.

Since an enormous number of developments are in progress, the image must be incomplete. Nevertheless, we think the reader can scarcely avoid being impressed by the glimpses of the electronics revolution portrayed here.—PHILIP H. ABELSON and ALLEN L. HAMMOND