its substrate, serotonin, falls, and that of the product, *N*-acetylserotonin, rises. Increased synthesis of the pineal hormone melatonin then follows as a result of *O*-methylation of *N*-acetylserotonin by hydroxyindole *O*-methyltransferase. The responsiveness of the pineal β-adrenergic receptor and the consequent synthesis of *N*-acetyltransferase change; the receptor becomes supersensitive after decreased exposure to the catecholamines noradrenaline and isoproterenol and subsensitive after increased exposure to the catecholamines. The circadian rhythm in pineal amines appears to arise from a biological clock present in or near the suprachiasmatic nucleus in the hypothalamus. This clock in turn is modulated by inhibition by environmental light.

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Science and National Policy

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All of us, of course, are well aware that there is a strong undercurrent in our industrial societies of antiscience, antitechnology, anti-industry, and anti-economic growth attitudes. Yet, when one examines the needs of the overwhelming majority of the citizens of this world, it is difficult to conclude otherwise than that more and better science, technology, industry, and economic growth are required. I concede that we have not always been sufficiently conscious of the overall quality of life, but I would argue that only through a vastly improved knowledge of ourselves, our environment, and our universe are we likely to be able to attain and sustain an improved quality of life. I would further argue that economic growth is anything but obsolete and that such almost universally accepted indices of quality of life as life expectancy, infant mortality, literacy, and years of schooling completed all correlate strikingly with even such an admittedly limited measure of economic welfare as gross national product per capita.

Measures of Economic Welfare

Writing in 1972, economists William Nordhaus and James Tobin attempted to answer the charge by critics of economic growth that we have not been growing at all in any meaningful sense. Because, along with all economists, they are aware that gross national prod-

uct is not a very good measure of economic welfare, they constructed a primitive and experimental measure (MEW) in which they attempted to allow for the more obvious discrepancies between gross national product and economic welfare. Among other things, they imputed dollar values for the services of consumer capital, for leisure, for the product of household work, and subtracted some of the disamenities of urbanization. They concluded that in the United States mean economic welfare grew at 1.1 percent per capita per year over the 30 years from 1935 to 1965 as compared to 1.7 percent for net national product; that while MEW has thus been growing more slowly than net national product, it has been growing; and that "the progress indicated by the conventional national accounts is not just a myth that evaporates when a welfare-oriented measure is substituted" (*1*).

Unquestionably, burgeoning populations make it more difficult to improve economic welfare and quality of life. Yet, it is anything but clear that the situation is hopeless. A net reproduction rate of 1 will produce zero population growth when a suitable population-age distribution is attained. The net reproduction rate in the United States dropped from 1.75 percent in 1960 to 1.2 percent in 1967 and an estimated 0.96 percent in 1972 (*2*). Even with a net reproduction rate of 1 or below, the population of the United States would go on growing slowly for another 25 or 50 years while the bulge in age distributions, which is a product of our more fertile years, dissipated. Over that span of time, the population of the United States would level off somewhere around 250 million, hardly a catastrophic number.

Nor are we alone in this trend toward net reproduction rates at 1 or below. Intrinsic annual population growth rates have been dropping steadily among most of the industrialized nations, and it is highly probable that the average for the entire industrialized world for the year 1973 will show a net reproduction rate of about 1. It is true that the intrinsic annual population growth rates of the underdeveloped countries are still relatively high, but their population growth rates indicate a steadily downward trend, and there is no reason to assume that they will not continue to do so. It is also important that, since 1965, the average growth in real per capita gross national product in the less-developed countries has been about 3 percent and, in 1972 and 1973, was only slightly behind that of the developed countries.

I would conclude that while the increasing population pressures on the resources of the world do present real difficulties, they are not such as to be unsolvable, and that more and better science, technology, and growth in economic welfare are vital components in meeting these difficulties.

Economic Growth Justified

Nor is it likely that, as postulated by Forrester in *World Dynamics* (*3*), or as indicated by the Club of Rome's study (*1*), exhaustion of the world's resources in the very near future will apply catastrophic limits to growth. All these models ignore the functioning of the price system, which is the main mechanism in our economy that forces the gradual transfer from resource-intensive goods to other things, and hence automatically works to reduce requirements per unit of national output and does so steadily and gradually with time. It is true that there are defects in the market system in that the costs of such disamenities as air pollution, water pollution, noise, and visual pollution are usually not encompassed. But surely this is not an irreparable defect, and our national attention can be much more profitably directed to curing these deficiencies than to the incredibly expensive and self-defeating demand for zero economic growth.

Indeed, for most of the people of the world, the choice is very clear. They will organize their societies to achieve what they feel we in the United States, Europe, and Japan already have. Further, since here in the United States, as recently as 1971, about half the families in the country had incomes of less than $10,000 per year, and almost one-fifth had incomes of less than $5,000 per year (*4*), the overwhelming majority of our own citizens will not see themselves as having attained an affluence sufficient to accept, other than by force, mechanisms of political and social organization that would limit the future growth of our economy sufficiently to prevent their attaining an appreciably higher level of material welfare. Thus, I would conclude that the need and the pressures for growth are not only great, but completely justified.

Edward Denison has made extensive studies of the sources of economic growth in the United States and in other countries. He found that, over the period 1950 to 1962, 58 percent of the United States' increase in national income per person employed came about as a consequence of improved knowledge, combining the impact of education on our labor force and such applications of knowledge as technological innovation and improved management (*5*). Denison's findings are based on the usual national income accounts with their admitted deficiencies in measuring economic welfare. Yet, it will almost certainly be true that knowledge will play an even more significant role in attaining a satisfactory growth rate in true economic welfare, which by its very nature must be much more complex than attaining satisfactory growth rates in the gross national product.

Until early 1973 there was in the Executive Office of the President of the United States a science advisory function that included the President's Science Adviser, the President's Science Advisory Committee, and the Office of Science and Technology. In January 1973 the Office of Science and Technology and the President's Science Advisory Committee were eliminated, and the remaining functions were transferred to the National Science Foundation. Dr. Guy Stever, director of the National Science Foundation and a fellow guest tonight, was made the President's Science Adviser.

I am sure that many of the science and technology activities of significance to the Executive Office of the President can be handled as well or even better with this new mechanism, but I am also convinced that science and technology are such significant elements in our overall culture and so vital to economic welfare that the complete elimination of the science advisory mechanism from the Executive Office of the President would appear to have been unwise.

I certainly would not suggest restoration of the old science advisory mechanism. Instead, I would advocate an approach which would involve science and technology and the forces of

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knowledge generation and diffusion more intimately in the policy-making activities of the Executive Office of the President.

After extensive debate on the economy following World War II, Congress enacted the Employment Act of 1946, which created the Annual Economic Report of the President, the Council of Economic Advisers, and the Joint Economic Committee of the Congress.

National Development Act (of 1976)

I suggest that there would be no more fitting way to celebrate the 200th birthday of this nation than with a new act, the "National Development Act of 1976," as a natural evolution from that Employment Act of 1946.

As I envision it, this new National Development Act would declare that it is the continuing policy and responsibility of the federal government:

1) To seek for every citizen an ever-improving standard of living defined in the full context of quality of life as well as material affluence.

2) To encourage all practicable means to foster and promote free, competitive enterprise to fulfill needs of our citizens for goods and services.

3) To use government intervention, but with caution and understanding, to modify the market economy, to affect the price structure of goods and services so they reflect the value of such public goods as the environment, or to impose overall regulation where the welfare of society (such as for health or safety) is concerned.

4) To require modes of federal intervention that will avoid government ownership of facilities and minimize direct government employment of workers.

5) To use all practicable means consistent with its needs and obligations to assure that there will be useful employment opportunities, including self-employment, for those able, willing, and seeking to work and to promote maximum employment, production, and purchasing power.

6) To conduct its affairs and interventions so as to provide a stable and growing economy with a minimum inclination to inflation.

7) To encourage a broad enlargement of educational opportunities with emphasis on equal opportunities for all men and women throughout life, including especially combined work-learning programs aimed at consistently upgrading the skills of workers everywhere and to their broad cultural betterment.

8) To foster the growth of knowledge throughout the society in all fields including science and technology, art, and the humanities with particular emphasis on those basic areas vital to the continued economic growth and social development of the United States, including the use of research and development as key tools in attaining national objectives.

The National Development Act also would call for the President's submitting to the Congress in January of each year a national development report, reviewing the overall quality of life in this country, including not only the overall economic performance in such usual parameters as gross national product and net national product but also a broad variety of such necessary aspects of quality of life as health, an improved environment and educational and cultural attainment. It would establish a council of national development advisers in the Executive Office of the President comprised of five members, each exceptionally qualified to analyze and interpret developments in economics, education, science, and technology and to appraise programs and activities of the government in light of the policy declared by this act. The act would also create a joint development committee made up of eight members of the Senate and eight members of the House of Representatives to make a continuing study of matters relating to the national development report and to make recommendations and findings to the several committees of the Congress dealing with legislation requisite to advance the policies established by the act.

I believe that the public debate which would accompany the preparation for this National Development Act of 1976 and its enactment would serve (i) to inform the citizens of this country as to the base of their material affluence and quality of life, (ii) to point to approaches which are most likely to alleviate or remove the very real faults of our society, (iii) to emphasize and utilize the enormous capabilities of this nation in science and technology through the applications of research and development aimed at the attainment of national objectives, and (iv) to protect and enlarge the freedom and dignity of every citizen.

I suggest a mechanism such as this National Development Act to assure that the deliberate seeking, diffusion, and application of knowledge become an integral and continuing part of policy-making in our government as it seeks to fulfill its responsibilities in attaining an improved quality of life for all our citizens.

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