WORLD DESIGN SCIENCE DECADE 1965-1975

FIVE TWO YEAR PHASES OF A WORLD RETOOLING DESIGN
PROPOSED TO THE INTERNATIONAL UNION OF ARCHITECTS
FOR ADOPTION BY WORLD ARCHITECTURAL SCHOOLS

Phase I (1965) Document 4
THE TEN YEAR PROGRAM

**World Resources Inventory
Southern Illinois University
Carbondale, Illinois, U.S.A.**

Phase I (1965) Document Four

THE TEN YEAR PROGRAM

by: John McHale

(Chapter headings of this document are from the outline of 'The Five Two Year Increment Phases of the Ten Year World Facilities Redesign' - published in Document Two (1964), "The Design Initiative", by R. Buckminster Fuller)

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Other volumes in this series are:

Phase I (1963) Document One:	Inventory of World Resources, Human Trends and Needs. by: R. Buckminster Fuller John McHale
Phase I (1964) Document Two:	The Design Initiative by: R. Buckminster Fuller
Phase I (1965) Document Three:	Comprehensive Thinking by: R. Buckminster Fuller

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PREFACE

As Document Four in the World Design Science Decade 1965-1975 series, this volume is intended to expand further the exploration and documentation of the main themes set out in the other publications in the series. Its specific function within the program, and in relation to the VIII World Congress of the International Union of Architects for which it is prepared, is to provide some guide materials and notes on the forward phases of the ten year world students' program.

This program was proposed by R. Buckminster Fuller to the International Union of Architects (IUA) at their VI World Congress in England in 1961. He suggested then that the architectural and environmental planning schools around the world be encouraged by the IUA to invest the next ten years in a continuing theme of 'how to make the world work'--how to redesign the world's prime tool networks and environment facilities so as to make the world's total resources, now serving only 44% of humanity, serve 100% through competent scientific design and anticipatory planning.

The first part of this proposal called for the initiation by the world schools of a beginning survey of the total chemical and energy resources now available to man on a global scale, and of human trends and needs in relation to these resources. To assist in the furtherance of such work we prepared Document One (1963), "Inventory of World Resources, Human Trends and Needs," which was presented to the world architects and students at their International Symposium in Mexico City, October, 1963. This 'inventory' outlined the main aspects of man's present world resource position and provided a broad survey of his major trends and needs relative to his resources.

Document Two (1964), entitled "World Design Initiative," dealt specifically with the manner in which the world students might assume the initiative, and gave procedural outlines and examples for the conduct of generalized design science exploration.

During 1964 there was a considerably increased response to the program by schools and student groups around the world. Various student projects on the first phase of the program, "World Literacy re World Problems", will be forwarded for exhibit at the VIII World Congress of the IUA in Paris, July 1965. The IUA has set aside exposition and conference space for this purpose.

For this Congress we have prepared two documents; Document Three - "Comprehensive Thinking" is a selection of the writings of Buckminster Fuller which includes a statement to the world students on the theme, 'Geosocial Revolution'; and the present document, fourth in the series, will be available at the Congress to aid in discussions on the forward implementation of the ensuing phases of the program with the world students and teachers.

It should be emphasized here that the overall planning and ultimate success of the "World Design Science Decade" rests with the world students' initiative, encouraged and assisted by their schools, universities, and professional organizations.

This volume, though entitled "The Ten Year Program", is not intended to usurp that initiative, or in any way lay down definitive limits for the program's forward development. It represents no more than a series of notes, trend indications and information sources which may be useful in assisting forward the overall evolutionary development. The role of the "World Resources Inventory" center at Southern Illinois University is essentially that of a coordinating agency which may acquire, and disseminate, information in various areas and provide guide analyses of the world trending shown in the cumulative data. Such a function, during the initial gestation period of the world program, may be best performed by such a central agency. It is important to point out, however, that in the preparation of projects for the VIII World Congress, various student and school groups have spontaneously assumed the responsibility for coordinating work in their various countries.

In discussing more closely the forward phases of the ten year world facilities redesign program, it may be useful to append the outline of these which was published in Document Two (1964) "The Design Initiative" by R. B. Fuller.

Phase 1. World Literacy re World Problems - World Industrio-Economic Literacy and its design science solution by dramatic educational tools for realization of the world resources inventory of human trends and needs, --world's people. Together with dramatic indication of potential solution, by design science upping of the overall performance of world resource units to serve 100% instead of the present 44% of humanity.

Phase 2. Prime Movers and Prime Metals - Review and analysis of world energy resources differentiation between 'income' and 'capital' energies - design of more efficient energy utilization. Analysis of circulation and scrap recycling of prime metals. Redesign towards comprehensive and more efficient use and reuse 'assemblies' with higher extraction of performance per unit of all invested prime metals in use.

Phase 3. Tool Evolution - Differentiation and evolution of machine tools - the integration of these tools into the industrial complex; review and analysis of generalized and specialized tools - automated processes and control systems-redesign and replanning of total world tool complexes and instrumentation systems, i.e., total buildings, jig assembled by computer within optimum environment control air delivered ready to use in one helilift.

Phase 4. The Service Industries - Analysis of world network of service industries, i.e., telephone, airways, communication services, hoteling, universities. General extension of dynamic network operating principles into formerly 'static' areas of environment control both internal and external. Frequency modulated, - world planning of three shift, 24-hour use of facilities, i.e., most industrial facilities as yet operating under obsolete agricultural dawn to dusk, single frequency usage. Trans-sonic 1800 mph air travel transcends day-night and seasonal characteristics. Men literally jump out of night into day and out of winter into summer in minutes. Thus, local patterns of facilities employment trending swiftly into 24-hour succession of users, i.e., electrically lit telephone booths by roadside.

Phase 5. The Evoluting Contact Products - Usually phrased as 'end products'--there are, in effect, no end products but only the contact instruments of industrializations human ecology services which are the plug-in or latch-on terminals of service industries, e.g., the telephone, transportation and other communication units, the motel (bathroom and bed)--and eventually the world-around environ control service unit.

This outline has been employed as the main chapter headings for the present volume. In laying out these phases in successive increments we indicated that the continuing aspect of each increment stage should be considered as overlapping and interweaving with all the other stages, e.g., the first phase "World Literacy re World Problems" may be seen to be active in all phases. Phase 5, "The Evoluting Contact Products" is also, in a sense, integral with three, "Tool Evolution" and four, "The Service Industries", development. There are no artificial division between each stage; their separation is for convenience or prior emphases only. Each phase should be viewed as an aspect of a continuous dynamic process out of which emerges a natural hierarchy of priority considerations.

In addition to the chapter texts, which explore and comment upon each phase, various other relevant items have been placed in appendices at the end of their appropriate chapters, e.g. the Geoscope development as an example of a 'dramatic educational tool' relative to the literacy of world problems is placed at the end of Chapter One. This chapter, as of immediate concern, is given the greater space in the present volume.

Within the 'plan' outline itself it may be noted that the various elements have their own 'time' developments and priorities - of first things first. Phase One's emphasis on the central function of education and communication in overall planning is based on the need for an informed world society--not only in the sense of recognizing its major problems and their possible solutions, but also in that the goals and values essential to such planning may only be established and adjusted according to the enormous range of future possibilities now available to world man. There are many possible alternative directions which now require his conscious choice, and collaborative participation in the implementation of directions chosen. No 'ideal solutions', however seemingly efficient, may be imposed on man in the long term evolutionary sense.

Phase Two focuses upon the prior physical base of energy and materials which is required for evolution into Phase Three--the ordered development of tools to make tools which are the fundamental backbone of not only traditional industrialization but of the new 'agri-socio-industrial' complex in which 'industrialization' means not only the heavy 'capital' industries but the inter-related 'tooling up' of the network of chemical, biological and consumer industries which go to maintain the overall human ecological process. This extended industrial network leads naturally into the Service Industry Phase in which the main ecological <u>service</u> networks are viewed as encompassing many of urgently required facilities now operating at low efficiency as piecemeal autonomously isolated components, e.g., world shelter and health facilities. Such 'service' industries are not 'product oriented' industries - they do not produce things - but are the visible terminal facilities through which man 'taps into' invisible support systems which are anticipatorily designed to meet the widest range of his requirements. The <u>plug in</u> or terminal facility we have called the Evoluting Contact Product--a concept which is increasingly more representative of industrial network function than the traditional 'end product' in manufacture function--the responsibility extends beyond the supply of the product to the service-in-supply function.

As a planning outline this scheme may be employed in various ways.

1. As a take off point for a series of planning and development studies in which the various components of each phase are given different weightings and priorities. For example, if in examining Phase Four (The Service Industry) it seemed feasible to plan for the deployment of living facilities over a large area, we would then need to ask in Phase Three (Tool Evolution), "What kind of transportation systems might be necessary, and what kind of tooling up

and production facilities may be required?" If 'autonomous energy sources' are indicated, this would refer back to Phase Two (Prime Movers).

In relation to such programming of objectives through the planning system, students will find it useful to consult the 'Universal Requirements Schedule', of R. B. Fuller, in Document Two, also his 'Omni-Directional Halo' papers in Document Three.

2. The content and sequence of subject matter in the outline may also be viewed as contributing to new curricular orientations in environment planning and design science studies. There is patently required for its fullest implementation a framework of intensive studies which proceed methodically through the acquisition of knowledge and skills in a broad spectrum of disciplines to their employment in large scale systems research, development, and forward planning.

The forward work of the World Design Science Decade may thus be viewed as requiring a major shift of emphasis in the education of the architect and environment planner. It defines a much larger context of social initiative and responsibility, and charges the emergent architect and planner not only with designing the major ecological environment facilities required by man but also with designing the means whereby such full environmental advantage may be made available to all men.

John McHale
Carbondale, Illinois
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N.B. Selected reading lists for each phase are included at the end of chapters.

WORLD LITERACY RE WORLD PROBLEMS

Phase 1. "World Industrio-Economic Literacy and its design science solution by dramatic educational tools for realization of the world resources inventory of human trends and needs, --world's people. Together with dramatic indication of potential solution, by design science upping of the overall performance of world resource units to serve 100% instead of present 44% of humanity." (R.B. Fuller, 1964)

In a few generations man's world has shrunk from a vast planet, whose surface was still uncompletely known and whose peoples were relatively remote strangers to one another, to a continuous neighborhood, in which no man is more than a few hours distant from all other men and on which communication between men may be instantaneous. Man-made satellites circle this neighborhood many times in one day and the repercussions of major events affecting part of the human family are swiftly felt throughout the whole world.

> "It is a closed community now so interdependent that every mistake made can be exaggerated on a world scale and every opportunity seized, in corporate wisdom, can mutually benefit the whole of mankind."[1]

World society's awareness and understanding of the problems accompanying these changes has not, however, kept pace with the changes themselves. The world's literacy regarding its major problems is still relatively inadequate. Historically accustomed to geographical remoteness and comparatively isolated autonomy, man still tends to think in these terms. His attention is most easily focused on local tensions and upheavals which are in themselves the surface manifestations of the larger problems rather than prime causes. Literacy regarding world problems lies initially with the understanding of their global nature, and with their underlying prime causes rather than local surface events.

In communicating the urgent and critical nature of the present situation, it is important to realize, also, that the main problems with which man is faced are not intrinsically new in his experience. All human history is a long record of the struggle against hunger, disease, war and ignorance. The present gravity of these familiar aspects of the human condition, and that which gives them unique urgency, is their expanded dimensions. This vastly increased scale and magnitude has been compounded, paradoxically, through man's successful advances in science and technology which are his prime means of combating them--by shrinking the physical distance between men, he has increased the critical interdependence of all men, by making man more secure against hunger and disease he has added astronomically to the number of men, and by displaying the material results of his increased knowledge and capabilities he has created a tremendous demand by all men to share in the accumulated 'wealth' and knowledge.

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[1] "World of Opportunity", Vol. 1, United Nations Report on Conference on Application of Science and Technology for Less Developed Areas, 1963.

This present imbalance in the availability of such material advances to all is the prime aspect of our recurrent global crises. The world is clearly divided into 'have' and 'have not' peoples--as the geographically unequal distribution of physical resources becomes further sharpened by a correspondingly inequable distribution of the knowledge, and the technology resulting from that knowledge, which transforms the physical resources of the earth into higher standards of living for man.

The solutions to the major world problems, of food, health, education, shelter, etc., lie in this combination of knowledge and material resources--and these are, at present, mainly preoccupied in maintaining less than half of humanity at relatively high standards of living as compared to the majority of the human family. The increasing pressure of the other 'have not' peoples to attain to such higher standards manifests itself in various 'local' tensions and upheavals around the world. Such manifestations of unrest, tension and social upheavals, though productive of so much pain and suffering, are not then, in themselves, the main problem. They are expressive indicators of the gravity and urgency of the main problem, but this remains one whose dimensions are unlikely to be reduced by the piecemeal applications of local economic and political ameliorative solutions. The major problem is still - and requires emphatic statement and restatement - <u>how can we render the world's total resources adequate to the maintenance of the whole human family at advanced standards of living for all?</u>

No simple sharing out of the world's present physical resources would answer this requirement fully, even on an emergency basis. Though our knowledge of resource 'convertibility' is progressing to the point where we may state that our total resources are virtually inexhaustible, our present implementation of that knowledge lags some way behind. Under current extraction and conversion rates the per capita availability of the requisite metals, for example, required to sustain the already advanced country is steadily diminishing. That the standards of these countries continue to increase despite the relative decrease in the world's resources in-use per capita is due entirely to the indirect manner in which developing technology improves with each advance and constantly does more with less for each unit of invested resource. The way in which to render the world's total resources adequate to the upping of living standards for the whole human family lies therefore in the <u>conscious</u> application of this <u>'more with less'</u> principle --with the designed application of the highest performance per pound technologies to the solution of the given problems.

Central to such comprehensively designed application of the highest technological potential to the solution of the world's problems lies -- adequate statement and restatement of the problems themselves, and their interrelations and priorities. Within such comprehensive statements will be found the direction of possible solutions. The stating and restating of the problems and the communication of such statements is a prerequisite for their solution. Both in stating clearly to themselves, and to the world at large, what the parameters of the various problems are the students will find that they will progressively define the sequence of planning steps required for their solution.

Effective, dramatic and adequate communication of the problems and their potential solutions is, in itself, the most practical first step towards eventual successful solutions. This may be achieved by:

<u>One</u>, increasing awareness and understanding by the world peoples of the intrinsically global nature of their problems, less attention and energy may be diverted then to the relative ineffectiveness of 'local' piecemeal solution attempts.

Two, creating an atmosphere of participation in the consciousness that the solutions to the world's problems are within man's own cooperative control, and that work towards their solution may be engaged upon by all men, further communication will be looked forward to, assisted and welcomed.

Such specific solutions and partial plans, as are advanced, will be severely criticized. Not only in that they come from students, but in that they attempt the confrontation of such problems on a world scale. Much as the idea of confronting similar problems on a regional scale, or national scale, was resisted until quite recently. Such criticism is a necessary evaluation procedure for any successful planning. No scheme or plan for the large-scale solution of any human problem, which is not understood, critically assessed, and accepted by society at large can be successful in any long-term sense.

How may we prepare comprehensive statements of the world problems?

Since the initiation of the world student program in 1961 the potential sources for such statements have increased enormously. In August, 1963, we produced for the program the Inventory of World Resources, Human Trends and Needs - Document One (Phase I). 1963 was an extraordinary year with regard to the publication of such world inventories, and their coincident appearance may well mark some evolutionary turning point in man's forward progress. At least four such major surveys were published within a few months of each other:

Science and Technology for Development - United Nations Eight Volume Report on the U.N. Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas.

Science and the Future of Mankind - edited by Hugo Boyko, (published by Dr. W. Junk, the Hague), the first in a series of volumes to be issued by the World Academy of Art and Science which envision the organization of a global working team to create 'an inventarium' of all natural resources.

Technology and Economic Development - Scientific American, September, 1963. A special issue, later issued in book form, by thirteen international experts on the relationships between the advanced societies and the developing countries.

Resources in America's Future - Hans H. Landsberg, Leonard L. Fischmann, Joseph L. Fisher, (Patterns of Requirements and Availabilities 1960-2000). Published by Resources for the Future, Inc.: Johns Hopkins Press, U.S.A. Though differing in character from the others in its specifically 'local' concern with one nation, this very detailed inventory still contains much valuable world information.

By reviewing and compiling together such powerful statements, and the accompanying world data surveys which have been made by various other authoritative world organizations and conferences, we are now in the position to communicate successive dramatic and forceful pictures of the major global problems as the various phases of our program are developed. Where such statements are inadequate for areas where accurate data is not yet obtainable, this will direct attention to the need for such data as part of the overall problem statement. The indexing and coding of such information for swift and cross-related reference will require working groups to develop efficient information storage and access systems including the use of electronic data processing systems and computor centers where these are available.

In touching upon the overall educational value of the World Design Science Decade program- it may be useful to comment briefly upon the comprehensive discipline and self-education which will be required by the student participants. In preparing such initial 'statements' alone it will be necessary to develop an overall 'sense' of the whole of the complex evolving ecological patterns of man in relation to the earth. This will require a sound 'generalized' knowledge of the basic sciences--physical, chemical, biological and social--and of the ways in which these contribute to the overall concepts of human ecology and our knowledge of the earth's 'biofilm' within which man's human activities are sustained. In assessing the magnitude and trending of man's evolutionary development, the histories of the sciences, and the development of their auxiliary inventions and technologies, are important, as they give a feeling for the effects and 'frequency' patterns of such various innovative discoveries on world society.

Designing new ways for the dramatic and effective communication of the 'statements of the world problems', inventories of resources and world trend patterns, will require not only the investigation of appropriate international standards and symbols, but also the evaluation of all available mechanical and electronic recording, displaying devices, film and video-tape, etc. The design exploration and invention of such new educational tools will be a formidable exercise! The design of the appropriate structural systems for housing such tools, so as to allow of their use under many different environmental conditions will provide unique training in high advantage 'performance per pound' technology.[2]

How may we go forward to prepare plans and solutions?

A useful first step may be to review the many national and international five-, ten-and twenty-year plans, etc., and large development schemes which have been prepared and put into practice in the last few decades. These will be of great value as background material to the whole program even though many are concerned with specific solutions to given local problems. Their varying priorities, successes and failures may be profitably noted.

In reviewing the various aspects of these plans in their different industrial, agricultural and socio-economic sections it will be necessary to acquire a 'working' acquaintance with the pertinent disciplinary areas which contribute their specialized studies to each section. This, in turn, will lead to some familiarity with special problems in industrial and agricultural technologies and processes, and with the necessity to maintain a constant 'file' review of developing technological processes and inventions and their relationship to developing economies.

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[2] The Geoscope Appendix to this chapter will give some further aspects of this part of the program.

Studying such plans will also give many insights into the nature of the planning process, and lead to the acquisition of the necessary planning tools.

Current literature on planning will reveal considerable emphasis on the new 'systems' tools and various techniques for 'simulating' large socio-economic and industrial complexes. The computer is now widely used in planning through its capacity to handle vast numbers of variable factors in swift review. It gives great flexibility in choice of plan directions and enables the planner to anticipate the measurable effects of various alternate strategies.

Attention should also be given to local and specific problems considered within the comprehensive framework of the large scale plan. For example, in studying the world transportation network there may seem a need to develop a new form of local transport for certain areas. This should be a separate study, within the whole, but should be designed so that the new local transport would also operate in any part of the world. It would be a 'generalized design solution'. This attempt to design 'generalized case examples' to specific problems will be a useful pragmatic criterion in many areas of environmental tool design planning.[3]

Much of the work in this program will probably be conducted outside the regular curriculum of the schools. It will require that the students set up their own cross disciplinary group to consult with various authorities and specialists in the university and the outside community.

In this way the program will provide an unique training situation. The students will be involved with, (a) initiating and organizing their own work group and allocating various member functions; (b) consulting with individual and authorities in the university, industry and government; (c) coordinating their work with other regional and national groups; and (d) working with other groups widely distributed around the world.

For those schools who decide to adopt the program within their curricular framework it will provide an exciting and stimulating challenge. This kind of work does provide, in effect, the new curricular orientations towards comprehensive 'generalized systems' environment planning which are being sought by architecture and planning schools around the world.

In this section on World Literacy re World Problems it seems pertinent to include at this point some brief review of the problems themselves and their solution directions. As our primary concern, though the solution of such problems is with the raising of living standards, it will be useful to quote here the nine point living standards index suggested by the United Nations:[4]

Health	Housing	Clothing
Food Consumption & Nutrition	Education	Recreation
Employment & Work Conditions	Social Security	Human Freedoms

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[3] The 'Universal Requirements Schedule' (for dwelling) of R. B. Fuller is a useful guide here: Ref: Document Two, "The Design Initiative."

[4] United Nations Publication, E/CN. 3/179 - E/CN. 5/299, New York, 1956.

These headings identify the major deficiency areas--the problems. Though mainly considered here in relation to the lesser developed countries, such areas of deficiency are still to be found in relative degree, even in the highly developed countries. They remain world problems. In reordering them--according to their interrelations and the bearing upon them of related deficiencies in resources, available energies, technological development, etc.--we may still note that such divisions tend to observe their basic interdependence. To state this simply-adequate food is essential to maintain health,which is also affected by the quality of shelter--all affect education and are, in turn, affected by education.

Food

As the main link in the poverty chain- malnutrition, infectious disease, infestation and low productivity--food would appear to hold prime priority. Man cannot 'live' effectively when chronically hungry. He cannot work or study efficiently,nor reason well beyond his next meal. His resistance to disease is lowered and his whole potential as a human being is at a low ebb.

The U.N. Food and Agricultural Organization estimates that at least a third to a half of the world's people suffer from hunger and malnutrition--more than 1,500 million people. Only about one sixth of the human family may be said to be well fed.

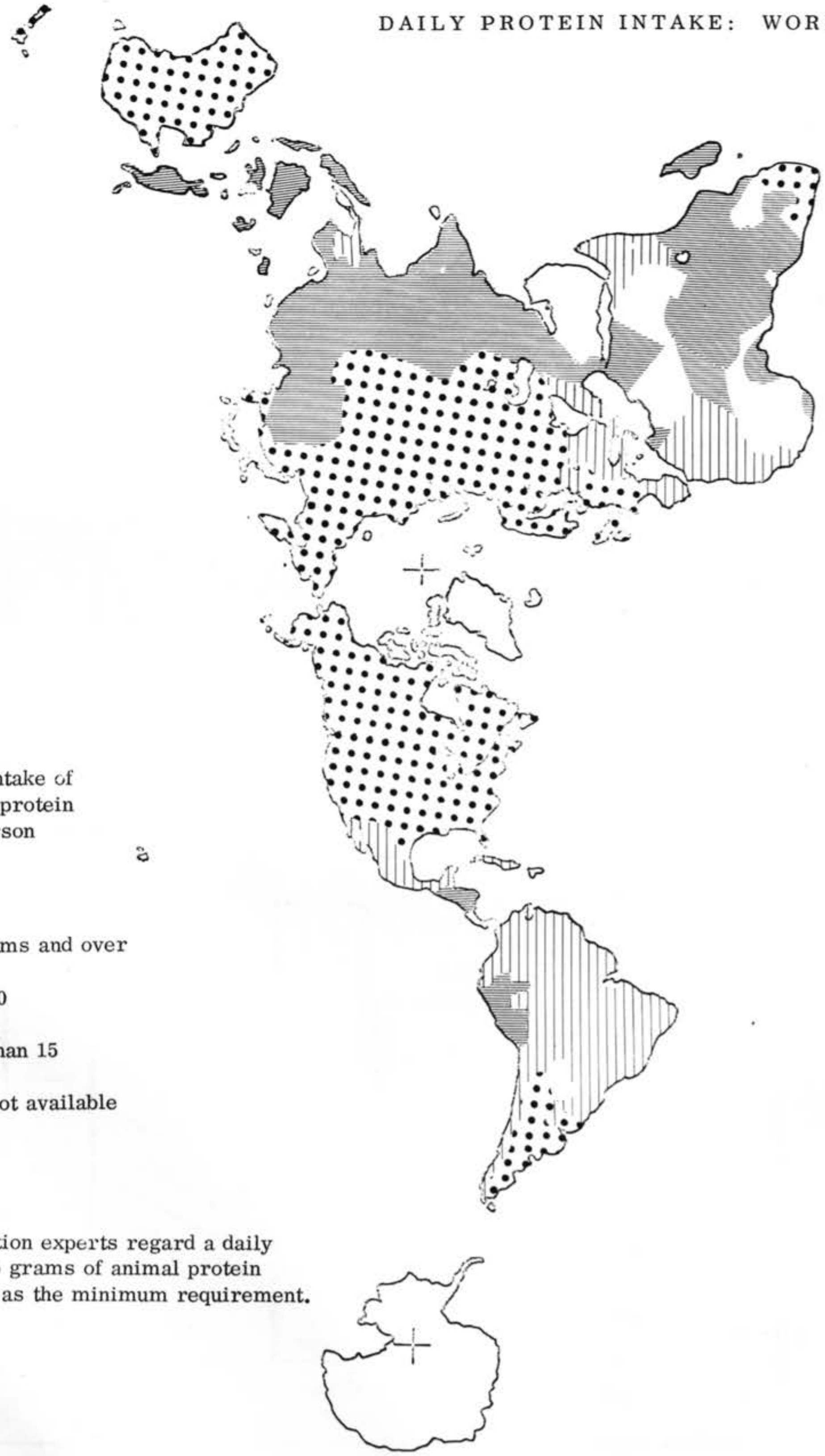
During the World Food Congress, June, 1963, it was stated that, "Every day of this week some 10,000 will die of malnutrition or starvation. In India alone, 50 million children will die of malnutrition in the next 10 years. More than half of the world's three billion people live in perpetual hunger."

The comparative per capita daily consumption though sufficiently dramatic still conceals deficiencies. For example, the average person in a high standard country consumes approximately four pounds of food per day as against about one and one fourth pounds of food per person in the low standard areas; but, the former is not only higher in weight but in dietary value. The necessary protein for growth and health requires inclusion in the diet of meat, fowl, fish, eggs, milk, cheese products, etc. The high standard diet contains more than 20 per cent of such products; the low standard, less than 5 percent--in some countries it may be 85 per cent rice, deficient in protein, fats and vitamins.

The human family presently depends for its food primarily on about three per cent of the land surface which is arable and about six per cent of grass pasture land. Cultivation and other land uses, from which food is gained proceeds precariously on about nine inches of the usable topsoil and depends, mainly, on traditional methods which have changed very little through the centuries.

Though food requirements and population growth tend to be bracketed together, there is a certain confusion in doing this which may still be tied to the 19th century Malthusian view--suggesting that human population would increase beyond the limits of the earth's capacity to sustain it, and mankind would ultimately perish. As we remarked in our first volume in the series, this view was compounded with over simplified versions of Darwin's 'survival of the fittest' and seemed to indicate that the 'have' nations would increasingly look after their own, and let the less fortunate sections of the world fend for themselves. It is erroneous, not only in that the balance of man's survival has been based rather more on eventual cooperation than on immediate competition, but in that our capacity to accommodate much larger numbers of people at increased standards of living has vastly increased in the past hundred years.

DAILY PROTEIN INTAKE: WORLD



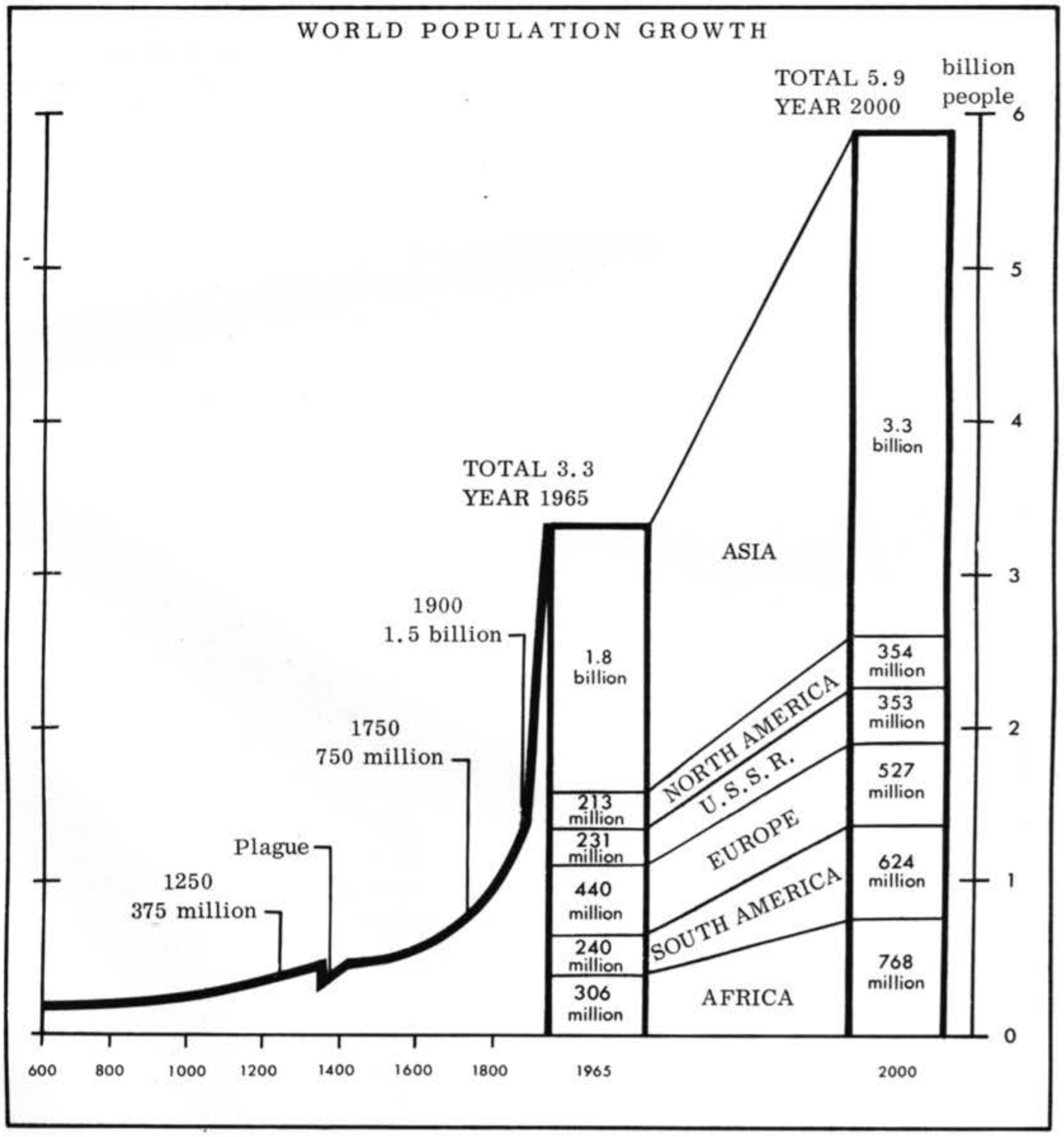
Daily intake of
animal protein
per person

- 30 grams and over
- 15 - 30
- less than 15
- data not available

Some nutrition experts regard a daily intake of 15 grams of animal protein per person as the minimum requirement.

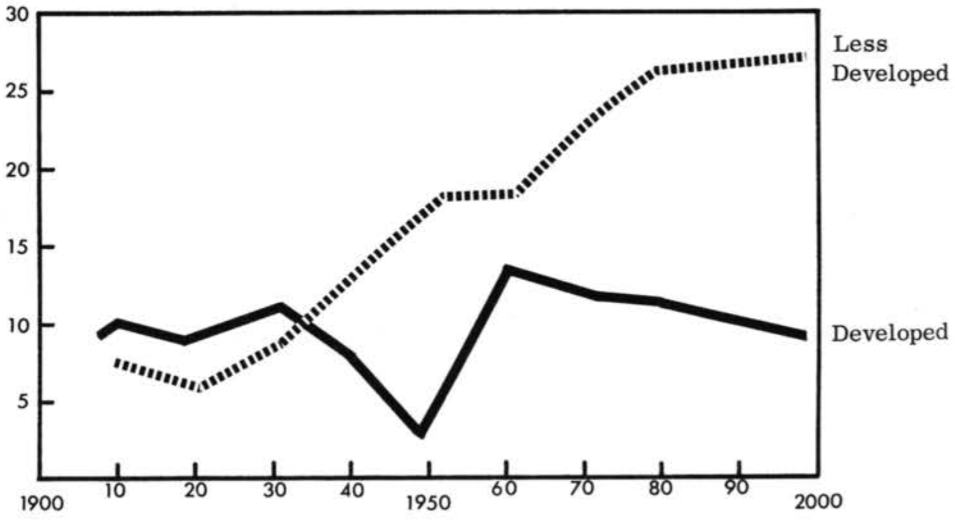
Source: Change/Challenge/Response. Office of Regional Development, Albany, N.Y. 1964.

It may be useful however, to include a note on population trends at this point. The world's estimated total population is 3,230 million, of which 450 million live in the twenty or so 'high standard' countries. In 36 years, at 2000 A.D., the U.N. estimates that world population will be more than 6,000 million. The question of population control has been of major concern for many years and various measures have been introduced with varying degrees of success. Though it is of extreme importance that such measures be continually explored, it is also worth noting that the carrying capacities of the world's land alone has been estimated at from 5,000 million to 16,000 million people.[5] Population control is usually advocated as priority for the lesser developed countries, yet in the high standard countries population is still on 'apparent' increase--though too little weighting is given here to the increase in life expectancy in such countries, which means simply that more people are alive at older ages. In regard to the U. S., a recent authority states:



RATES OF POPULATION GROWTH BY ECONOMIC REGIONS

(PROJECTED AT CURRENT GROWTH RATES)



Source: Transitions. Vol. 7, No. 2, 1964.

"There is, of course, another good reason for not tying population control to food: it is that this tie eliminated from consideration rich countries - and in particular surplus countries such as ours. Our population is increasing faster than it ever has; our major nutrition problem is overweight, our major agricultural problem is our ever-mounting excess production. Does anyone seriously believe this means that we have no population problem? Our housing problems, our traffic problems, the insufficiency of the number of our hospitals, of community recreation facilities, our pollution problems are all facets of our population problem."[6]

In this sense population is not a major problem at all, but the provision of nutrition, increased services and overall education within society relative to the needs of population.

To return to food, it is generally agreed that we require vast increases in our world food production. Central to this is the questions of overall social and agri-industrial development. Though much is made of traditional methods,intensively used,as increasing crop yield per acre, the facts are that 'more people can be fed off an acre than on it'. In the industrialized high standard countries less than ten per cent of the labor force produces more than enough for the population. No country has progressed towards adequate nutritional levels for its population, and the avoidance of recurrent famine, etc., until at least half its population has shifted from subsistence, or 'marginal surplus', agriculture to industry. This development direction is also required not only to provide the other necessary industrialized services, e.g., transportation, communication, housing, etc., as well as food processing industries, but also to provide a more efficient agriculture. As will be discussed in the notes on housing or shelter this does necessarily mean moving people - - -which is the usual objection--but may bepredicated onany preferred pattern of deployed or central living, which people prefer.

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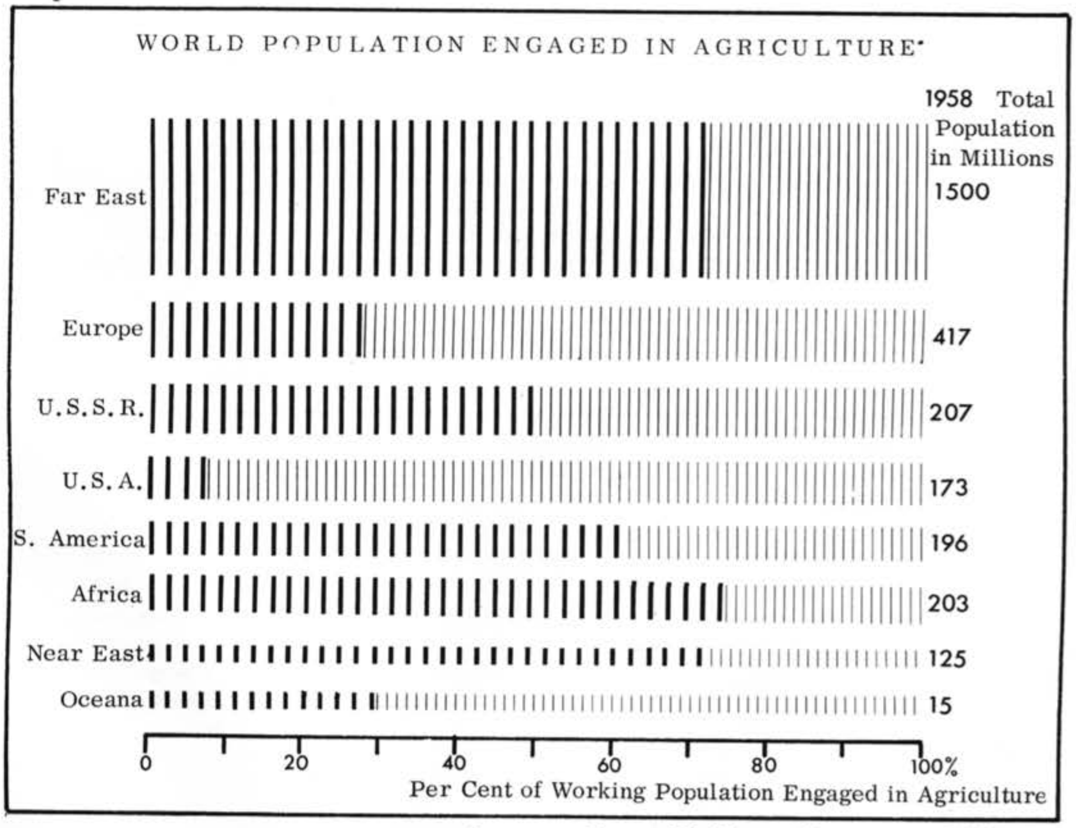
[5] Relative to the need for 'inventories', the U.N. World Demographic Report states that death statistics are at least 90 per cent complete for only about 36 per cent of estimated world population and among 14 per cent of world population there are no death registration records kept. UN:E/CN. G/159.

[6] Jean Mayer, School of Public Health, Harvard University. "Current" magazine, December, 1964.

Another aspect of the situation at present is the destruction of food by pests--about 20 per cent of the world's food annually. The FAO has calculated that rats, insects and fungi destroy annually some 33,000,000 tons of essential foods in storage--enough to feed, for example, the whole U.S. population for a year. In the same report, attention is also drawn to the millions of tons of food whose full utilization is prevented by disease and parasites in the human body, e.g., intestinal worms prevalent in the tropics may 'take up' a third of the food a man ingests.[7]

This again underlines to the extent to which the overall nutrition problem is amenable to direct scientific and technological solutions. There are also the larger solutions to be offered through the full employment of such means as new farm lands from the jungles, deserts and icecaps: the possibilities of increased yields up to 30 per cent more through fertilizers: the doubling of the world's fish catch and the 'farming' of the continental ocean shelves. The bio-synthesis of food products has also advanced greatly in recent years.

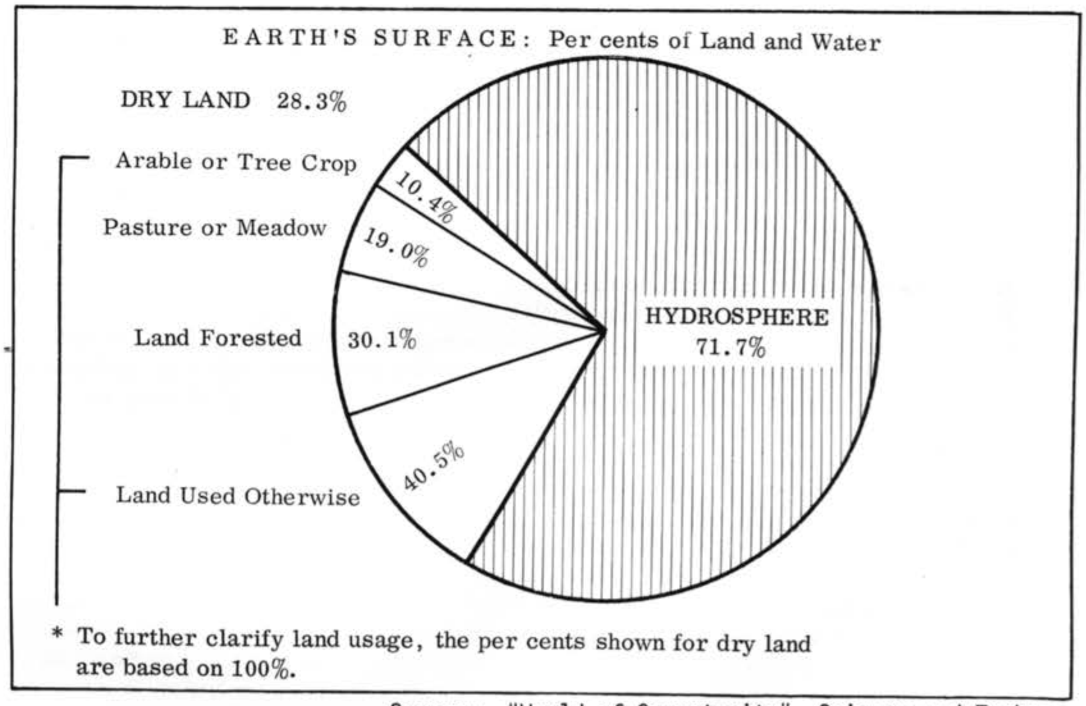
Most of the world's arid land may be reclaimed by irrigiation -- about 200 million acres now idle could be made productive.



Source: Change/Challenge/Response. Office of Regional Development, Albany, N.Y. 1964.

Water

Water is not only a vital ingredient in food production, but even more critical to the daily maintenance of life itself. Ninety-seven percent of earth surface water is in the oceans, and of the remaining three percent,fresh water,much less than a quarter is directly available to man's use. This tends to give a static picture, however, of a dynamic cycling process--as the continuously renewed sources of fresh water are drawn up as moisture from the oceans and precipitated over the land. Our use of water has been, and is, prodigally wasteful even in the face of the enormous ocean reservoirs. Overall agriculture accounts for about 50 percent of the water measurably consumed in human activity--to raise wheat for a two and one-half pound loaf of bread it takes 300 gallons, which is also the theoretical daily requirement to sustain the overall living standard for each person. Industrial use has increased consumption enormously, e.g., requiring 250 tons of water to make one ton of steel, but industrial usages tend to be less inefficient than 'household' use[8] relative to recycling of water, sewage disposal, pollutants, etc. Even much of the household water consumer in developed countries has already been used at least once for other industrial or domestic purposes.



Source: "World of Opportunity", Science and Technology for Development. Vol. 1. U.N., 1963.

Adequate water supply, both in relation to food producing and industrial use, is a grave problem even in the developed countries who not only face critical shortages because of increased usages but also due to misuse of existing sources, excessive pollution of surface water and lack of overall water 'policies'. Though the newly developing capacities in water desalinization will help solve emergency conditions, it is generally agreed that a world water policy is urgently required both for direct water use in agriculture, industry, etc., and for the development of the enormous potentials in hydroelectric power.[9]

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[7] After the Seventh Day, Ritchie Calder, Mentor Books, c1961.

[8] See Phase Four, "The Service Industries"

[9] UNESCO International Hydrological Decade began January 1, 1965.

All of these solution directions underline ways of increasing and augmenting existing resources through higher performance of resource investment and eventually come to the need for the design and adoption of some world 'servicing' system for their effective implementation.

Health

Even in our cursory statement of the nutrition problem it was evident that only some kind of comprehensive confrontation would enable one to progress towards an adequate statement of the overall parameters of the problem. The interrelation between health and nutrition, and conversely, nutrition may depend on being healthy enough to produce enough food, or to utilize efficiently food consumed. 'Health cannot be taken for granted when about 75 per cent of the world's inhabitants are without an adequate and safe supply of water, when 85 per cent depend on the most primitive methods for the disposal of excretia and refuse.'[10]

Health and the expectancy of life years are among the most markedly unbalanced factors in the relation between the 'have' and 'have not' areas of the world. Those living in the developed countries have seen the pattern of disease change within their own lifetime and the expectancy of living rise by almost twenty years. For them, many of the most dreaded infectious diseases have almost disappeared, may be swiftly cured or are under control. For those living in lesser developed areas the picture is less pleasant. Close to 380 million are still exposed to malaria; ten million suffer from leprosy; more than four and one half are ravaged by yaws.[11] Where many of these are being steadily eradicated, e.g., yaws which affected an estimated 50 million is now 'down' to the four and one half million above, due to antibiotics--others are still spreading. Schistosomiasis, a chronic infection caused by a blood parasite, today threatens some 200 million people and has not been wholly checked. Approximately one third of the world's population suffer ill health in one form or another; in many areas half the children still die before the age of five, largely as a result of malnutrition.[12]

Though the discrepancy has been emphasized between the developed and lesser developed countries is, in a sense, one of difference in types of prevalent disease, with, of course, the general balance of acute 'killing' diseases among the lesser developed. The health problem of the 'high standard' nations reflects, in part, their population make up, with degenerative diseases high, as in the aged; and, in other ways, their present lack of ecological design in the use of the industrial complex. Many of the respiratory diseases, allergies, cancers, whose causal agencies are not completely determined, may be linked to chemical pollutants in the atmosphere; overloaded and archaic sewage and water control systems still allow of considerable microbial pollution of rivers, lakes and streams with accompanying disease. Another aspect is the reported increase in the proportion of mental illness. This has been estimated as accounting for almost 50 per cent of all hospital accommodations in England and U. S. A considerable number of such patients, e.g., in England - 21 per cent, are over sixty-five years of age. This apparent increase would tend to be explicable, on the one hand by an increase in recognition, concern and care for the mentally ill, and the proportion of older persons whose lack of adaptation to rapid change has engendered various stress conditions.

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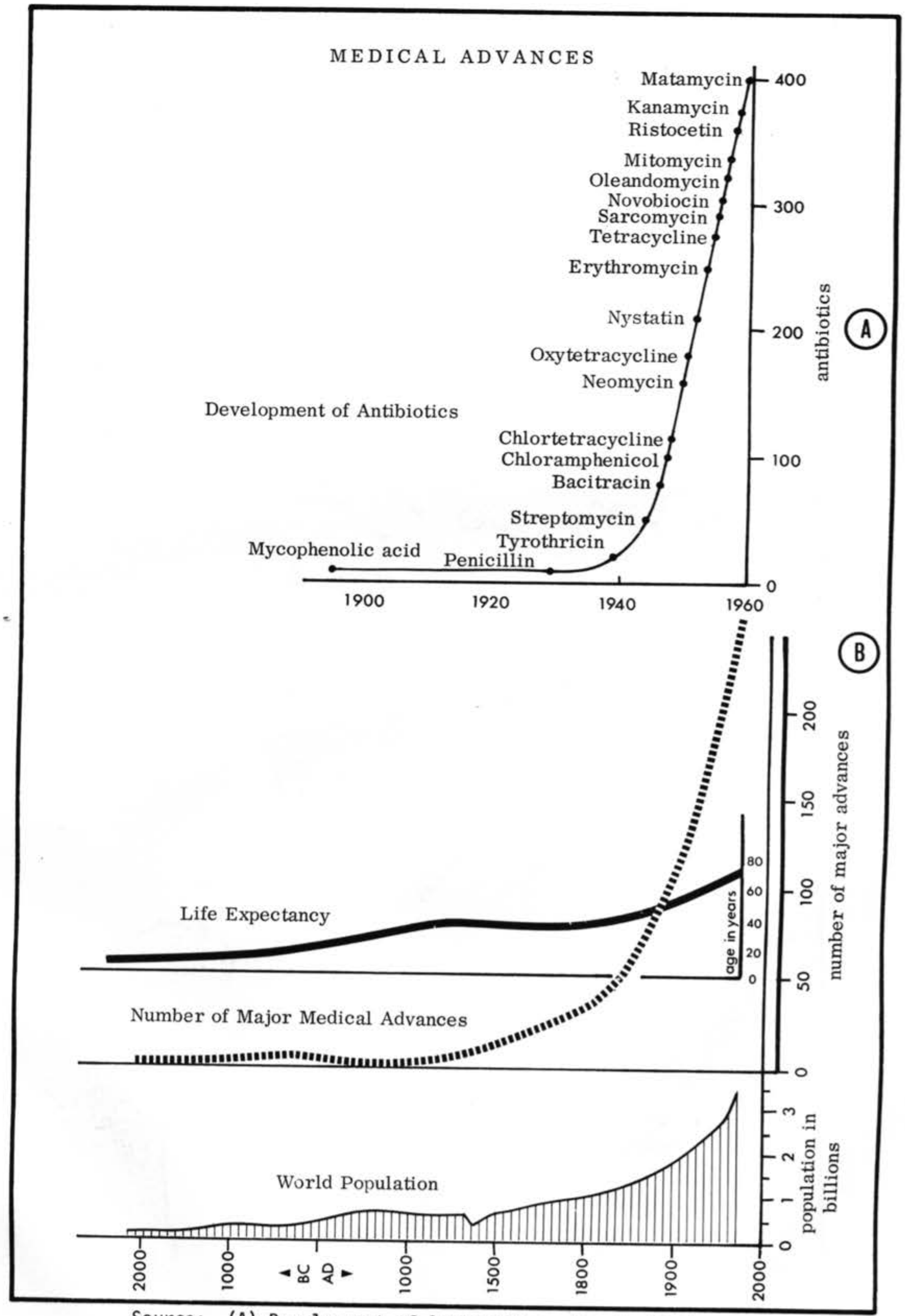
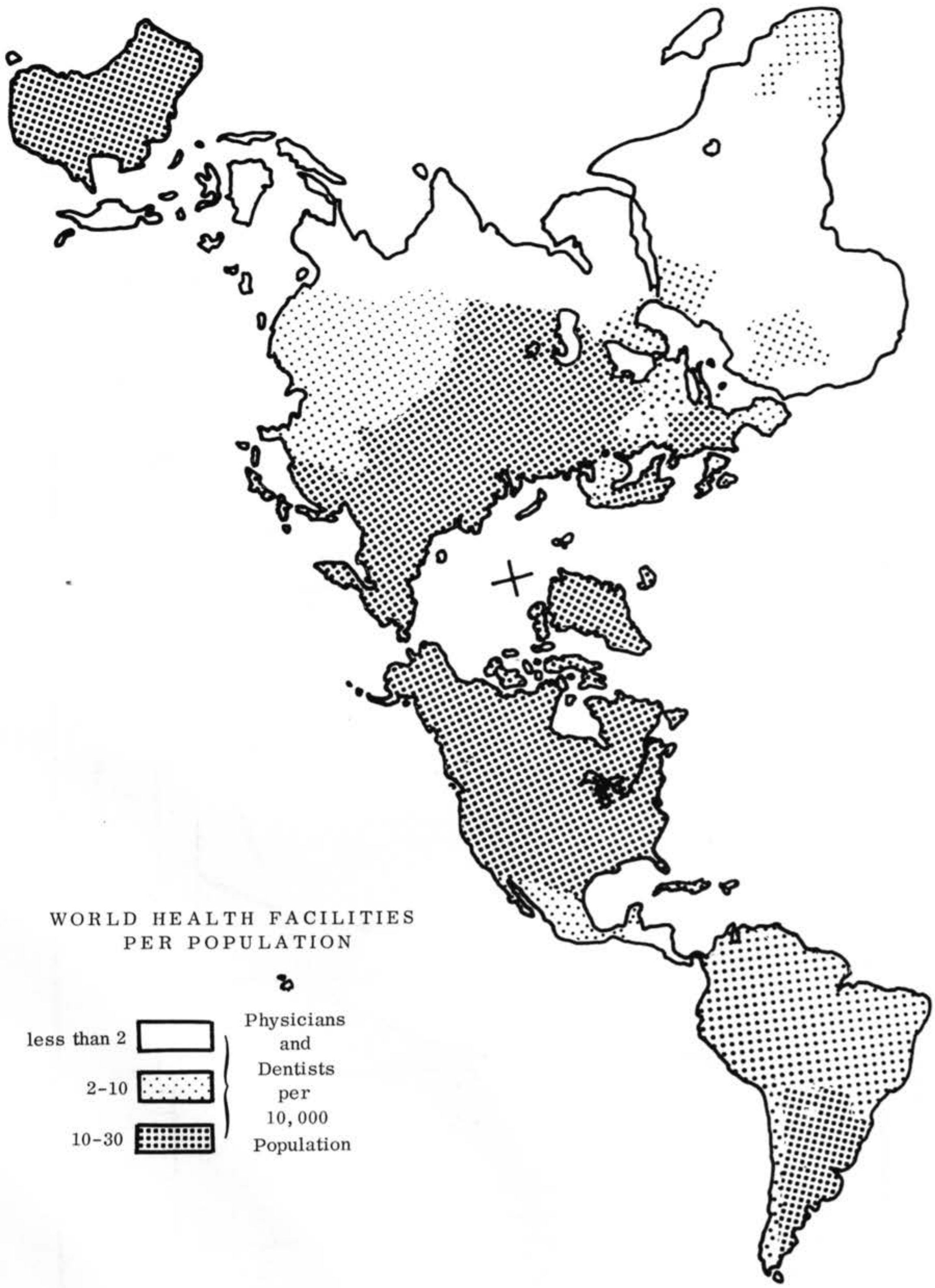
[10] Science and Technology for Development, Vol. I, U.N., c1963.

[11] Ibid.

[12] MD, January 1962.



Source: (A) Development of Antibiotics. Dr. H. Striner. UpJohn Institute, 1963.
(B) Man Plus Study. J.McHale. Southern Illinois University, 1964.



WORLD HEALTH FACILITIES
PER POPULATION
less than 2
2-10
10-30
Physicians
and
Dentists
per
10,000
Population

The consensus of the overall picture is still far from bleak. Medical science as one of the most comprehensively organized of man's 'systems' has made striking progress on the world scale in recent years. It has been noted, for example, that more lives have been saved from premature death in the past thirty years than have been lost in all the wars in all history.

One of the first major world medical campaigns against tuberculosis was launched on a global scale by UNRRA after World War Two. By 1951, 38 million people had received tuberculin tests, and 18 million were vaccinated providing up to 80 per cent protection. World blood transfusion services now span great areas of the globe, handling many thousands of gallons of blood and plasma annually and beginning to deal in inventories of organ transplants, eye corneas, etc. The World Health Organization now maintains an 'invisible global system' network of epidemic and plague control checks, as well as forwarding vast programs of curative and preventive medicine in many areas and countries with its work of mapping and 'inventorying' the world picture of man's 'internal ecology'.

The newly developed global communication facilities, available through orbiting satellite units, will further strengthen and extend this world health network. As this develops, remotely deployed medical scientists will be able to keep in touch more directly with others through world information centers. With satellite - relayed TV images and telephone, plus possible 'print out' facilities, a body of expert opinion on a matter of local or world urgency could be assembled in a short time and 'received' with all appropriate data, X-rays, etc.[13] One could draw upon a world research team and view findings directly, both micro and macro-scopically.

In general, man's developed capacities to cure, control and ameliorate disease conditions, to nurture the health of man throughout a much larger life span, demonstrate enormous gains in life itself. They are advances directly attributable to the use of science and technology within medicine--as comprehensively oriented by long practice and tradition.

Education

In terms of 'world literacy re world problems', education is both the problem and the means for solution of the problem--not only of this given area, but of most. It is the proven tool which immeasurably increases man's overall survival capability. By increasing his capacity to understand and control his environment, it is also that which eventually determines to a large extent his degree of personal freedom. In our developing world civilization, lack of education is a form of dis-enfranchise. The illiterate individual is constrained from full participation and access to his birthright as a human being--the right of all men to man's accumulated cultural heritage and to the 'practical' augmentation of his living which may be afforded by access to the highest scientific and technological capability.

We may 'order' the problem of adequate education in various ways, i.e., the need for general literacy and general education, for scientific and technical skills training and for the great range of specialized personnel required to organize our forward world development. The central world priority presently remains basic literacy: People and their developed intellectual and social competence are our prime 'natural' resource.

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[13] In May, 1965, the 85 pound 'Early Bird' satellite, hovering 22,300 miles above the Equator, allowed millions to observe a heart operation in progress.

The Director General of UNESCO, Rene Maheu, stated in 1964 that two fifths of the adult population of the globe cannot read or write--more than 700 million people. In certain areas of the developing countries the illiteracy runs as high as 90 per cent of the total population and in many countries the female population is almost entirely illiterate. No schooling is available for only about 45 per cent of the world's 550 million children between the ages of five and fourteen. Full access to the world communication systems, radio, TV, newspapers, etc., which are part of the education process, is also not presently available to millions around the world. According to estimates the number of illiterates is rising by 20 to 25 million persons each year.[14]

The design of education devices, facilities, and systems to combat this hard core of the main problem is a formidable challenge in itself . The efforts of international bodies such an UNESCO have been very great, but they will require a vast re-examination and augmentation of the whole educational process to really come to grips with the world situation. A recent 'World Conference for an International City of Science', (whose first priority would be to deal effectively with this problem and to set up what would be a world educational services industry[15]) made the following points:

1." It is increasingly evident that in the rapidly evolving countries traditional methods of instruction are of no avail. They are not intrinsically suitable for adults. Nor can they quantitatively meet the needs of children, because of the lack of suitable buildings and other equipment--this makes it necessary to consider modern methods of communication, and particularly visual media.

2. A new approach is clearly needed, through organized research and coordination. The project for an international scientific and technical complex is specifically designed to solve the urgent problems which this (present) situation leaves in suspense in all countries and which are particularly dramatic in the rapidly developing countries."

Further in discussing the priority for rapidly developing countries, this conference made certain points which concern our first phase theme and its initial emphasis on the design of dramatic educational tools for communicating 'world industrio-economic' literacy.[16]

...."In order to provide masses of individuals with a correct vision of the most important realities and to offer effectively a set of reactions appropriate to these realities, it is not indispensable to go through the whole process of teaching them reading and writing. Visual methods offer a specially valuable short-cut because they can be used flexibly and lend themselves to mass communication and the transmission of technical skills."

In defining further the function of "international scientific city', it is interesting to note also, that emphasis was placed on the order of primary research and development, design implementation and finally mass production of materials under, as underlined, the best scientific conditions of efficiency. This fits clearly with our program concept of maximal performance per unit of invested energy and resource as the key solution direction. Such high performance per pound technology is paramount in 'space' technology which affords many practical design cases.

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[14] UNESCO Courier, October, 1964.

[15] See later discussion: Appendix "Towards a World University"

[16] See appendix on "Geoscope"

IMBALANCE OF OPPORTUNITIES FOR
TODAYS WORLD GENERATION

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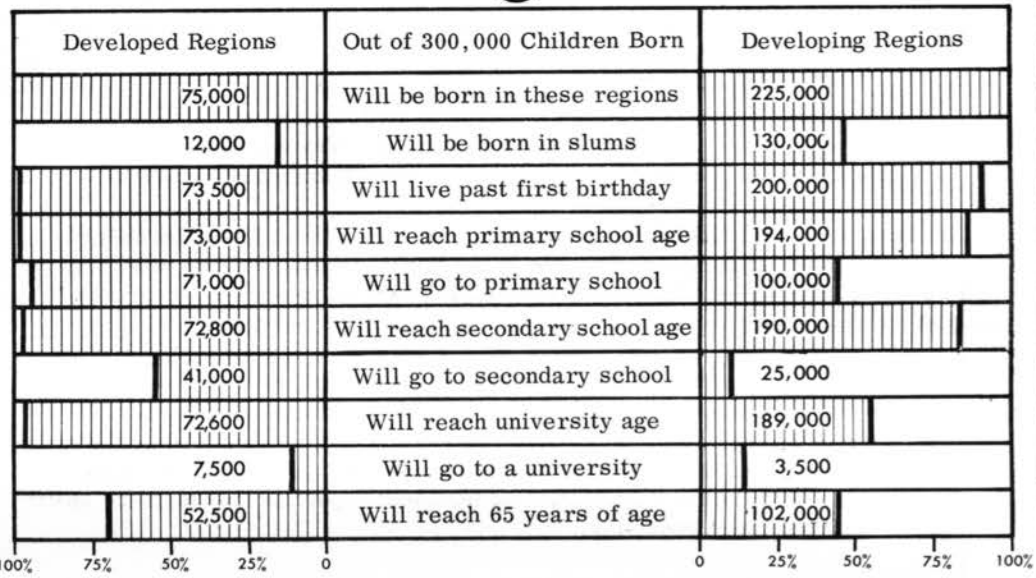
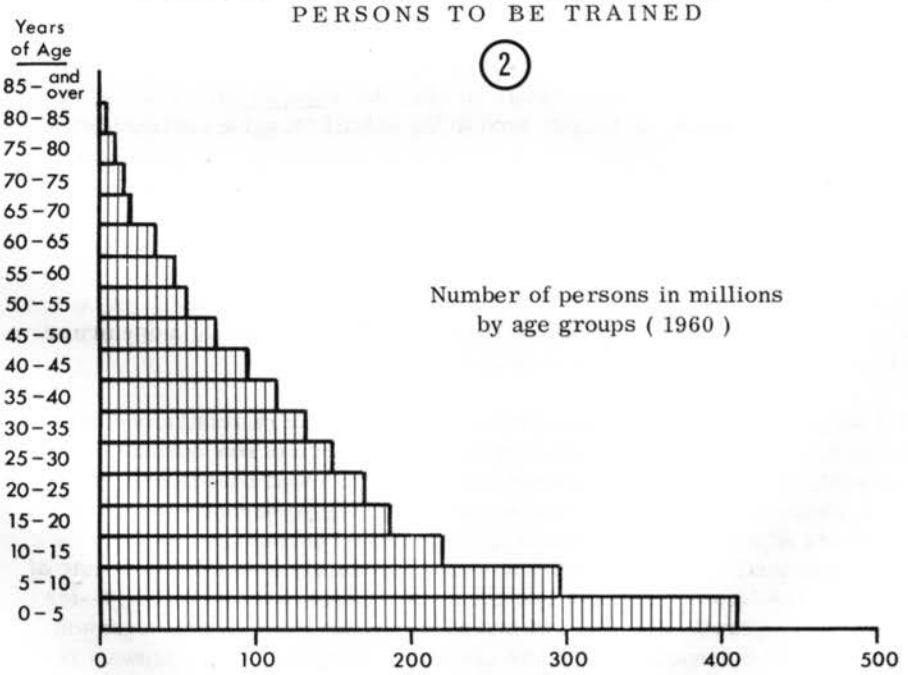


NUMBER OF UNSKILLED and/or ILLITERATE
PERSONS TO BE TRAINED

②



WORLD EDUCATION

Sources: (1) "Social Planning and Comprehensive Development". Demetrius S. Iatridis. EKISTICS, Vol 18, No. 109:409. Dec. 1964.
(2) W.T. Thom Jr. World Academy of Art and Science, 1964.

The following example is drawn from a recent NASA report:

> " The problem: the manuals, maps, star charts, emergency plans, etc. required in duplicate for the crew of the Apollo mission amount to 12,000 printed pages with a total weight of 79 pounds per kit. This involves a total weight of 158 pounds and a bulk of material, both unacceptable considering mission objectives.
>
> The solution: a package using microfilm in conjunction with a viewing screen to present the 12,000 printed pages rapidly. The package weighs three pounds and is about the size of a metropolitan telephone directory.[17] "

There is within the first phase of our program, also, the recognition that we have to arouse the minds of millions of people in the world towards their capacities to solve the world's problems--to dramatically stimulate their interest in the problems and to assist towards equipping them to contribute towards their solution.

The successful operation of the new communications satellites has placed an incredible tool for such work within the grasp of men. We are now, in a sense, all in the same 'room-sized world' with a world-wide communications service at our disposal. Such a service may beam the world's finest educators into the household in the most remote village or hamlet. The most sophisticated technical expertise may be made swiftly available to the most backward countries.

However, within the development of such great tools lies something of the dilemma which still faces education as a whole. Even in the advanced countries where universal education is still only about one hundred years old, the structure and content of much education has been little adjusted from its 19th century origins. Whilst great ingenuity is now being devoted to the technological development of new 'systems' of communication channels, through which the content of education may be more efficiently conveyed, hardly any attention is being given to the content itself--to what the 'through put' on the system is! Current academic programs, as taught, tend to lag behind changing environmental realities.

A 'cultural tradition' is an accretion of meaningful patterns which subtend individual and group survival. When too great a gap develops between the communicated tradition and the environ reality it may make for the non-survival of the culture. If conditions are such that a changed environ reality is not 'meaningful', and cannot be coped with, the whole culture may break down. This has been the plight of many primitive cultures faced with the 'alien' tradition of modern technology.

Up till our own period such changes in environ reality were relatively slow, but have gained tremendous impetus in the past fifty years. "Change is now normal" - yet most of our cultural, and therefore educational, strategies are still based on the older 'static' norm, in which change was an irregular and disturbing occurence to which the individual and culture adjusted--so attaining a further 'stable' normality. We know now that the apparent long-term stability of previous eras was merely a much slower rate of growth and change. The 'reality' for both individual and culture is always change--for the individual the ceaseless growth, development and decay cycles of the human organism itself, and for the larger community, the same cycle of overlapping and continuous regeneration relative to environmental change.

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[17] NASA Tech. Brief 65:100.30 (National Cash Register Co. subcontract).

It is obvious today that we can no longer think in terms of single static entities--one thing, one isolated area, one problem--but only in terms of dynamic changing processes and series of interacting 'events'. The content of our education, the bulk complexity and detail of our knowledge requires restructuring into new assimilable wholes so that it may be imparted, even at the primary levels, in terms of whole systems.

It is not only the bulk content of the knowledge within our educational system which tends to slow it down and the relatively archaic modes of imparting the knowledge, but -- that we have so rarely asked the question: "What is the minimal amount of knowledge which may be necessary to manipulate a field or group of fields, and in which order should it be imparted?"

Within 'world literacy re world problems' this 'problem' is also included. To approach 'world' thinking, we need to restructure our own knowledge and to create ways of thinking comprehensively about the system of knowledge.

Document Three[18] in our series may be usefully referred to here--also, the appended section on "Big Alphabets" may be viewed as an exercise in the restructuring of knowledge within the 'minimal' compass of a comprehensive and meaningful whole system.

Housing

Even in the advanced countries, housing is one of the last areas of human requirement to come under scientific design review. Though one of man's main 'environ tools', it has been allowed to develop haphazardly on a combination of local historical precedent, slow accretion of craft knowledge and local climatic need.

The family dwelling still bears little relation to the current capacities or requirement of our industrial civilization, and has nowhere reached the technical level of our other developed environmental tools. Man now produces, with ease, facilities of a similar and much greater complexity than 'house'. The automobile is one such example, weighing around two and one half tons, with approximately five thousand component parts--others would be air and ocean liners. The former is a mobile extension of the house, and the latter are virtually floating and flying houses, environment controls which routinely function under much more severe stress conditions than the ordinary house is ever required to in everyday circumstances.

On the global scale this discrepancy between potential technological capacity and low achievement is marked.

> "It is estimated that over 900 million persons in Africa, Asia and Latin America are without proper housing... if, as is recommended, 30 years were taken as the target to meet the housing shortage, and the average life of a house as approximately 25 years, then annual construction needed for current deficit, necessary replacement and population growth would be nearly 22 million units. By 1975, required annual construction would be almost 28 million units. The urban areas of Africa, Asia and Latin American constituting less than 30 per cent of the total population would account for over half of the recommended construction." [19]

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[18] Document Three (1965) "Comprehensive Thinking" - R. Buckminster Fuller.

[19] Study of International Housing: U. S. Senate, 1963.

Estimated Annual Housing Needs in Africa, Asia, and Latin America, 1960 and 1975 (In millions of dwelling units)[20]

	Africa		Asia		Latin America	
	1960	1975	1960	1975	1960	1975
Due to population increase:	0.84	1.50	5.30	9.40	1.10	1.70
To eliminate the deficit or shortage in 30 years:	.73	.73	4.80	4.80	.60	.60
To replace the stock:*	1.03	1.03	7.10	7.10	.90	.90
Total new housing needed:	2.60	3.26	17.20	21.30	2.60	3.20

*Average life of a dwelling unit is assumed to be 30 years in urban and 20 years in rural areas. The 1975 figures do not take into account increments of stock between 1960 and 1975.

In addition to the above figures, the UN estimated in 1961 that about three quarters of the world's population lived in substandard housing. This would give a figure of roughly 2,400 million people--in terms of six-person family dwelling units, 400 million would be required.

A side light on the above picture may also be afforded by a look at emergency situations created by natural disaster. The Chilean, Iran, Yugoslav and Alaskan earthquakes were recent examples. In the Iran disaster of 1962 some 70,000 were rendered homeless: in Skopje, Yugoslavia, 220,000 persons were without housing after the 1963 quake which destroyed 85 per cent of the city. It is significant that even with the combined efforts of all the major powers to rehouse the latter in emergency shelters, some 150,000 were still living in tents three months after the disaster.

Against the estimated deficiency in the underdeveloped nations alone, it may be salutary to examine current building capacity in one of the most industrially advanced countries, U.S.A. Of the 1.28 million units built in 1960, for example, no single builder or home manufacturer accounted for more than 5,000 units, and most erected fewer than twenty.[21]

The only possible solution to world need lies in the fullest application of the highest scientific and technological resource. It is more than likely that this will occur without benefit of traditional academic architectural practice or the present craft-building industry.

In his address to the IUA "International Symposium on Architecture" in Mexico City in 1963, Buckminster Fuller particularly stressed this in stating:

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20 The Population Crisis and the Use of World Resources, Vol. II, (Chapter - Housing and Population Growth, by Robert Cook, Kaval Gulhati), Publ. by WAAS, Dr. W. Junk, the Hague. 1964. Source given: UN, "World Housing Conditions and Estimated Requirements".

21 Report from Sub-Panel on Housing to the Executive Office of the President. Apr., 1963.

"In order to be able to put a man into space--to stay in space, not to make a few orbits--in order to have a man in effect, live continuously in outer space for weeks and months and possibly years, we have to solve scientifically the problem of mastering the ecological pattern of the human being and the metabolic pattern of the human being... We are going to have to compress the total ecological domain of man from approximately a one mile radius process into a ten foot radius process... In order to be able to send that man off into space, we have to scientifically anticipate and effectively service all his processes and psychological reflex requirements... In order to be able to do that, we are in effect, building a little space house. We had been used to the word 'capsule' which has hidden from man the fact that what science is really working on is a little house; not much room to move around in, no garden of roses outside, but nonetheless, a little house with a six billion dollar mortgage... The battle to attain the moon, or protracted living upon a platform in space, has brought about a race in capital funding initiatives between Russia and the United States specifically in relation to this little house, amounting to 6 billion dollars... This staggering amount is now appropriated to hire scientists to go to work to design and produce one little sky house, the first scientific human dwelling in history..."

Against this, for example, a U.S. survey of 1963 on the advanced 'technology' of housing pointed to the industry's 'break-throughs' as labor saving machinery ranging from power saws to fork lift trucks, from paint spray guns to automatic nailers! The largest producer attributes his main technological gains to wider stud placing and one coat paints![22] The medieval handcraft attitude is still only too evident--so-called 'industrialization' of the present building industry has only extended towards bringing the crafts in out of the rain to produce prefabricated parts. The current furore over the application of 'systems design engineering' and 'computorized building' has somewhat the same flavor. The use of advanced technological concepts to put up the same basically inefficient designs more quickly! This is somewhat similar to the lack of questions as to 'through put' on many of the newly proliferated educational 'systems'.

It is patent that the only solutions towards supplying the world need for adequate high standard housing lie with a comprehensively designed, universally operable and mass produceable facility. To consider house as an industrial 'end product' is no longer adequate to its efficient performance. For the fullest advantage of available, and developing technologies, we require the concept of house as that of rentable facility--like the telephone--with a full service, maintenance and replacement system.[23] Home ownership, in the context of our capacities and requirements, may be on a par with 'horse' ownership in terms of our present communication and transportation systems--no longer a desired prerequisite for living and supposed basic need, but one amongst many possible alternative choices. The function of the environmental tool facility designer is to provide the maximal degrees of freedom for such alternative patterns of living.

The Ecological Context

All the problems so far discussed also have a context. As 'human' problems they are not confined, however, only to the presently habitable surface areas of the globe.

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[22] The New Housing Industry, "House and Home", November, 1963.

[23] For more detailed discussion of 'house', see Phase Four ' The Service Industry'.

They extend out into the atmosphere--to the degree which the activities of man have altered, and continue to alter the composition of the atmosphere.[24] They extend also to the streams, rivers, lakes and oceans to the extent which man has altered these also. And they embrace the relation of the water, land and air to the extent that he has altered large areas of the earth surface--removing forests, changing vegetation cover through cultivation, redirecting and damming rivers, redistributing the metals and minerals, etc., changing the complex relations of animal population and their surroundings and even the larger cycles of evaporation, transpiration and precipitation. The global environment within which some 3,000 million humans exist has already been modified considerably by man, and we may presume that such modification will continue. When we speak of the habitable areas of the earth at this date, we are required also to take into account that men are presently experimenting successfully with the extension of living beneath the oceans, around the poles, and beyond the earth's atmosphere.

This modification of his environment by man to his own requirements has both positive and negative aspects. Positive in that it reduces, in considerable measure, the apparent long term insolubility of certain of his present problems. If we may irrigate the deserts, begin to 'farm' the oceans, 'interconvert' our resources on a growing scale, and extend our environmental control capacities to living anywhere on, within or above the earth, then prognostications about 'standing room only' in terms of population pressure, and 'global famine before the year 2000', etc., become unreal.

There is the negative aspect, of course. So far, our modification of the earth has proceeded with little regard for the intricacy of the overall ecological balances which maintain life on earth. We have taken little heed, for example, in modifying the environment for our own use, of the disruption of the populations of animals, micro-organisms, plants, etc., with which the maintenance of our own ecological cycle is still closely interwoven. There is presently -

> "nothing in untouched nature to compare with our extravagant use of energy and our failure to recycle essential materials. The leaves that fall upon the forest floor, the excreta and remains of animal life, and even the carbon dioxide exhaled in breathing pass through transformations that make them repeatedly available to sustain life, but the effluvium of cities and industrial plants, mining operations and mismanaged soil pour into streams and atmosphere. At best these wastes are often lost beyond recovery; at worse they are toxic. In any event they represent a loss of the ultimate potential of environment to sustain life and thus violate the model which has evolved through geological time. Time, space, motion, matter, the earth and the life upon--these are the phenomena whose inseparable relationship needs to be convencingly appreciated." [25]

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[24] "During the past century of industrialization....more than 400,000 million tons of carbon dioxide have been introduced into the atmosphere. The concentration in the air we breath has been increased approximately ten per cent and of all known reserves, of coal and oil were burned the concentration would be ten times greater." Vol. I, Science and Technology for Development, UN., 1963.

[25] The Perspeetive of Time, Paul B. Sears, Bulletin of the Atomic Scientists, Vol. XVIII No. 8, October, 1961.

We are now entering a period of delicate equilibrium relative to our continued modification of the environment. So far, we have proceeded with such modification without any clear knowledge of its overall short or long term effects. The present range and scale of modification, and those which we may anticipate as within the range of our developing capacity, are,however, now at such a point where continued unconscious and irresponsible use of the earth can be more irreparably dangerous to man than the use of the so-called deterrents with which he is so preoccupied. Within the 'literacy of world problems' it is essential that we adopt a basic orientation towards research on the nature of man's total environment. As medicine has patiently unravelled areas of man's 'internal' ecology, so must our environmental planning be firmly based on the knowledge of man's external ecological relations. Though one may term this, 'human' ecology, for verbal convenience, the complex life sustaining systems extend beyond man to encompass all other elements in the system--man is only our focus within the overall frame of reference. Just as the internal populations of 'flora and fauna' are essential to our individual metabolic processing so the various levels of plant and animal life are essential to the larger ecological process.

We need also to extend the physical and biological concepts of ecology to include the social behaviors of man--as critical factors in the maintenance of his dynamic ecological balance. Nature is not only modified by human action as manifested in science and technology--through physical transformations of the earth to economic purpose--but also by those factors, less amenable to direct perception and measure, which are politic-ethical systems, education, needs for social contiguity and communication, art, religion, etc. Such 'cultural' factors have played and will increasingly continue to play a considerable role in man's forward evolutionary trending and its effects on the overall ecology of the earth. Though not specifically directing his remarks toward ecological requirements, L.A. White has provided a useful classification of cultural processes:-

> "For our purpose, we shall distinguish three subsystems of culture, namely, technological, sociological, and ideological systems. The technological system is composed of the material, mechanical, physical, chemical instruments, together with the techniques of their use, by means of which man, as an animal species, is articulated with his natural habitat. Here we find the tools of production, the means of subsistence, the materials of shelter, the instruments of offense and defense. The sociological system is made of interpersonal relations expressed in patterns of behavior, collective as well as individual. In this category we find social, kinship, economic, ethical, political, military, ecclesiastical, occupational and professional, recreational, etc., systems. The ideological system is composed of ideas, beliefs, knowledge, expressed in articulate speech of other symbolic forms. Mythologies and theologies, legend, literature, philosophy, science, fold wisdom and common sense knowledge, make up this category."[26]

In seeking to employ the full spectrum of human activities as a format for ecological study, it is important that we bear centrally in mind that such studies are not concerned with 'conserving' or 'maintaining' and 'ideal' steady state, in the sense of arresting or controlling developing human processes--even if this were possible! We need, however,

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[26] White, Leslie A., The Science of Culture: A Study of Man and Civilization, N.Y. Ferrer Straus and Co., 1949, pp364-365.

to acquire such knowledge in order to anticipate the consequence of choosing particular solutions to our various world problems--to be able to lay out alternative directions and strategies towards accepted goals.

An interesting format for such extrapolations will be found in the later chapter, Tool Evolution. In summarizing a series of articles by leading authorities on "Life in 1984", Nigel Calder presents the various factors of 'change' in the form of a chart, and pursues each strand forward through its technical aspects, the possibilities arising from its introduction, the effects on the individual, its 'local' social aspects, and finally its global effects. The effects of 'change' forward may also be gauged in part from the re-examination of past changes and suggests the corresponding need to 'reconsider history (for example) in ecological terms for enrichment of our experience in making future decisions'.[27]

As has been stressed many times, the least predictable element in calculating man's possible future is man himself. His future is determined, not only by what is probable and possible--but by what he determines as necessary, allowable and ultimately desirable. At present, his ability to evaluate and determine his future goals, or implement solutions to his more immediate problems, lags far behind his potentially enormous capacity to fulfill any goals he may set or any probable solutions he may propose. However, the growing complexity of his globally evolving and interrelated systems of social organization and their supporting technologies now force him towards such an orientation. There is a dawning realization that man will have to involve himself more and more with the design of possible alternative strategies of future world development; with the conscious design invention of social institutions and organizations which will allow him to plan and implement such forward strategies which appear to be both necessary and desirable for the common weal. He will have to experiment 'with new institutional and managerial methods to <u>utilize</u> our great knowledge, just as (he has) experimented in the laboratories to <u>create</u> this knowledge'.[28]

The World Design Science Decade program attempts to provide such an 'experimental' framework for the designed utilization of man's knowledge on a global scale. Though its initial impetus occurs within architectural and environmental planning, the forward development of the program will require the collaboration and support of the full spectrum of man's skills and disciplines.

It is necessary, however, to stress its direct aim as concerned with the <u>practical</u> redesign of world environmental facilities, in the broadest sense, so as to render the world's total resources now preoccupied mainly in the service of only 44 per cent of humanity adequate to the service of 100 per cent through competent scientific design and anticipatory planning.

It is necessary, within our first phase theme, to stress also that no simple share-out of present resources will satisfy this requirement. It has been estimated, for example, that to raise the living standards of all countries throughout the world to that of the present highly developed countries, it would require six times more material resources that we have presently in world use. Whether such an estimate is correct or not is irrelevant. At our present general rates of energy conversion and material extraction and usage there is no swift way in which we might so increase, and share equally, <u>the amount of physical resources</u> available to us. On the other hand, it is in evidence that countries presently enjoying the highest standards of living have not reached this level solely on the amount of physical

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[27] F. Darling, <u>The Unity of Ecology</u>, Address to British Association for Advancement of Science, September, 1963.

[28] Michaelis, Michael, <u>Council for American Progress</u>, January, 1965.

resource available to them. Though historically they were able to initiate industrialization more quickly because of the close availability of key resources, the continuance of their rise in material standards has been due more directly to increased out-put per unit of invested energy resource. This increase in performance per pound of invested material is an inherent trend within the industrial process. As industrialization is the result of accumulated scientific knowledge applied via technological development to more efficient use of resources, so the 'principle' of increased performance is built into the process through the feedback of measurable performance criteria -- towards the continual and regenerative improvement of overall performance.

This inherent bias of technology towards increased efficiency of function, an 'organic' trend in an inanimate process is, of course, obscured in the general pattern of obsolete 'market' mechanisms and traditional 'economic' evaluations of the overall function of the industrial process. Again, this is due, in part, to the operation of historical precedent--no vast gains in energy conversion or productive performance were possible in the pre-industrial era in which the prime energy converters and producers were mainly human or animal. These 'mechanical energy converters' operated on a fixed ratio of performance to energy input which could be little improve . Gain in material 'wealth' generally accrued by multiplying the number of such energy converters operating on larger amounts of physical material. More was used to produce more! Our present developed technological capacity allows us clearly to use less and less energy and invested materials to produce more and more.

The swiftest way, therefore, to provide for the upping of living standards throughout the world becomes in itself both the prime problem statement and its most immediate solution direction. As Buckminster Fuller states in his paper, "Geosocial Revolution", addressed to the world students, it is a problem which 'bears repeating a million times'. It is:

> "How to triple swiftly, safely, and satisfyingly, the overall performance realizations per pound, kilowatts, and manhours of the world's comprehensive resources. To do so will render those resources--which at present design level can support only 44 per cent of humanity--capable of supporting 100 per cent of humanity's increasing population at higher standards of living than any human minority or single individual has ever known or dreamed of. To thus concentrate on the mastery of the physical service of man will also have its inadvertent profit increment, for to master the physical--intellectually--will bring into human intercourse a level of integrity of exploration of the metaphysical capabilities of man and the metaphysical ramifications of universe also heretofore undreamed of by man.
>
> Science and engineering say this is eminently feasible."[29]

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[29] See Document Three (1965) "Comprehensive Thinking" by R. Buckminster Fuller, Chapter - Geosocial Revolution.

Even the physical resources themselves, the metals and minerals, become more and more interconvertible as our scientific knowledge increases. Knowledge itself becomes increasingly the only prime resource. As U Thant, Secretary General of the United Nations, has recently stated:

> "The truth, the central stupendous truth, about developed countries today is that they can have--in anything but the shortest run--the kind and scale of resources they decide to have....It is no longer resources that limit decisions. It is decisions that make resources. This is the fundamental revolutionary change--perhaps the most revolutionary mankind has ever known."

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THE GEOSCOPE CONCEPT * (Appendix A)

The theme submitted to the IUA for the first two-year phase of the "World Design Science Decade" program is concerned initially with the 'literacy' of world problems-- "The design of a facility for displaying a comprehensive inventory of the world's raw and organized resources, together with the history and trending patterns of world peoples' movements and needs..." that is the assessment or inventory of those social, economic, and industrial trends defining world problems and their effective communication through dramatic educational tools, in such a manner as to catalyze their possible design solutions.

One such dramatic educational tool, outlined in the Fuller proposal, is the construction of a 200 ft. diameter miniature earth or Geoscope. This main display facility fabricated of light metal trussing would be correctly oriented on its polar axis in location, with basic geographic data marked accurately on its surface. Linked to an electronic computer, within which would be stored all available 'inventoried' world data, and wired on its interior and exterior surfaces with approximately ten million variable intensity light points under computer control, this would furnish a giant spherical television screen, allowing for the flexible display of dynamic world trending patterns at variably controlled display speeds. 'Viewing the stars through the semi-transparent land masses, from the centre of such a miniature earth would powerfully locate man in his universe and its electronic display facilities would enable him to see and conprehend patterns far beyond his normal 'timing' range... man recognizes a very limited range of motions in the spectrum of motion. He cannot see the motions of atoms, molecules, cell growth, hair or toe-nail growth; he cannot see the motion of planets, stars and galaxies; he cannot see the motions of the hands of the clock. Most of the important trends and surprise events in the life of man are invisible, inexorable motion patterns creeping up surprisingly upon him. Historical patterns too slow for the human eye and mind to comprehend such as changing geology, population growths and resource transpositions may be comprehensively introduced into the computer's memory and acceleratingly pictured around the surface of the earth.'[1]

GEOSCOPE DEVELOPMENT

Several study projects on such a Geoscope Minni-Earth facility have been carried out over the years, notably those at Cornell University in 1952, University of Minnesota in 1954-56, and at Princeton in 1960, directed by Buckminster Fuller.

At Cornell a 20 ft. diameter miniature Earth was constructed on which continental land masses were marked with transparent copper screen mounted on the openwork geodesic grid of the sphere. The latter could be entered and observations could be made through the surface of the Geoscope from its exact centre. The sphere was polarly oriented to the axis of the Earth and rotated so that Ithaca, New York, on the surface (corresponding to its real earth location) was in zenith. It was then locked in place to prevent any further relative motion. In use, this Cornell facility gave immediately certain direct sensations of true earth/universe relations--by observing the movements of the sun and stars against the grid lines relative to the polar constants the rotation of the Earth

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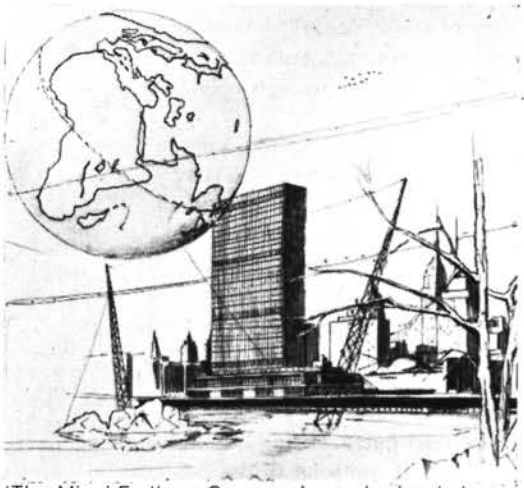
[1] Document One (1963), Appendix B: R. B. Fuller.

*(The Geoscope Concept is reprinted and adapted from 'The Geoscope - J. McHale: 'Architural Design'. London, December 1964.)

GEOSCOPE PROJECTS



'The Minni-Earth or Geoscope' may be located as a major world city's focal point, analogous to the Eiffel Tower, or as a continuing feature of World Olympic Games—or as in sketch, be suspended from masts mounted on the ring of rocks in midstream of New York City's East quarter, a mile distant from the East face of the UN Building to serve as a constant confronter, of all nations' representatives, of the integrating patterns, both expected and unexpected occurring around the face of man's constantly shrinking 'one town world' (Fuller)

Geoscope at Cornell University School of Architecture, 1952. 20ft diameter

Geoscope at University of Minnesota, School of Architecture, 1954. R. B. Fuller in foreground

Nottingham Geoscope: 20ft. diameter geodesic sphere with world map on plastic skin.

could be vividly experienced. The location of the sun at zenith at any point on the globe surface, where viewing was not blocked by the real Earth, could be verified accurately. The Princeton, 1960 Geoscope utilized data compiled during the several University of Minnesota studies in transferring the Fuller Dymaxion Map projection with detailed accuracy on a six foot geodesic sphere. By coordinating the triangulated plane surfaces of the map with the spherical geodesic this projection may give minimally distorted world geographical features at any scale. The six foot globe so constructed was probably the most accurate globe of this size ever made. Other big globes are usually more or less approximate enlargements of smaller standard units using spherical 'square' coordinates with relative distortion progressively enlarged in their land mass projections. The ratio of the Princeton Minni-Earth to real Earth was 1:7,000,000, thus rivers, shorelines, and small lakes could be shown in the fine details usually only found in small area maps.

Research into the Geoscope/Minni-Earth concept presently being conducted through the World Resources Inventory at Southern Illinois University, and the Buckminster Fuller Institute, ranges through the investigation of various multi-projection and panel wiring devices, such as multi-slide and 8 mm cinema units for the smaller scale systems and the incorporation of triangular-faced TV tubes now available with data storage and display through videotape. The system for the 200 ft. Geoscope, outlined above, has been fully analyzed and design schedules and costs for its complete production have been compiled.[2]

THE NOTTINGHAM GEOSCOPE

This unit, constructed at the Nottingham School of Architecture, England, is basically a 20 ft. diameter geodesic sphere of 1/2 in. diameter aluminum tube bolted together at the triangle vertices. This globe is covered with a thick plastic (polythene) film on which a world map is painted. Information on the global distribution of world resources and facilities has been plotted on this map using a symbol code for the various representations, e.g.:

1. Man shape to indicate one million population
2. Desk to represent educational data
3. Blackboard symbol to give world literacy pattern
4. Rail trucks to represent cement, iron, and steel production
5. An ear of wheat representing food gives number of calories per capita per day world picture, etc.

Numerical differences are shown by the size difference in the symbols. Color differences are also used when the same symbol stands for different materials (cement, iron, steel) or for different institutions (primary, secondary, higher education). When installed it is planned to leave a panel of the map insecured so that people can view the globe from the inside.

This project, prepared and coordinated by the School of Architecture, University of Nottingham, England, is a prime example of the type of collaborative design team work and planning which the continuing world program requires.

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[2] Such developments, including those specifically described in this article, are presently related to Fuller U.S. patent No. 2,393,676 and others pending.

The Nottingham School student group, working closely with BASA (British Architectural Students Association), acted as main center for construction of the geoscope and student groups in the schools listed below provided various world data compilations for plotting on the globe:

Bartlett School of Architecture (London)	-	Population
Bristol School of Architecture	-	Cement, Iron, Steel production
Liverpool School of Architecture	-	Literacy
Hull School of Architecture	-	Educational Facilities
Cheltenham School of Architecture	-	Food
Edinburgh School of Architecture	-	Health
Cardiff School of Architecture	-	Land Usage

All of this work was extra-curricular and was carried out through the initiative and commitment of the various individual students who formed the working groups. Mention should be made here also of the World Design project work at the Architectural Association School, London, which though not concerned specifically with the Geoscope, was coordinated within the general framework of the English students' World Design Science Decade Program.

THE COLORADO GEOSCOPE

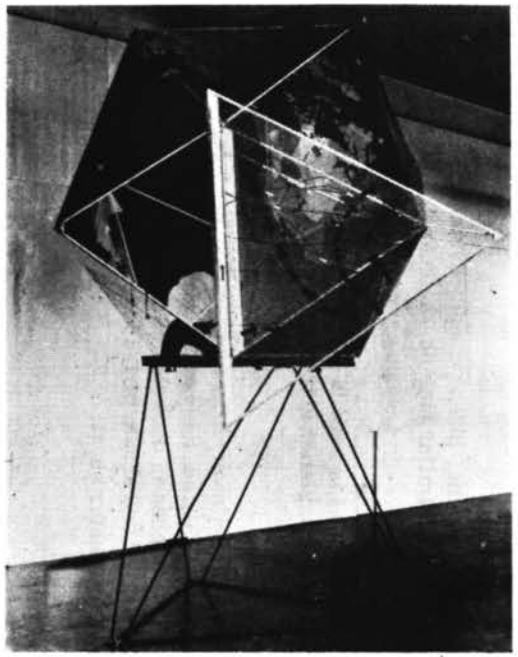
This study, whose description follows, was carried out under the direction of the author at the School of Architecture, University of Colorado, in April, 1964. The project was designed to investigate the possibility of such intermediate Geoscope models for use in education, or as part of a generalized information tool system for the storage and display of world data, operable at the individual or group research level. Such smaller scale devices may function autonomously or could be remotely linked to the centralized large-scale Geoscope which Fuller outlines.

The specific aim of the Colorado project, then, was to develop a global model which would allow for the display and storage of information on world resources, human trends, major geophysical cycles, etc., in a form which would enable their comprehensive and dynamic relationships to be viewed. Such a model should also serve as a flexible storage device for such data so as to provide swift review and demonstration of world trending patterns. It was further specified that the model should be of minimal weight and easily demountable for storage and transport. As noted on the preceding page this should be a fully operable unit; but so designed as to furnish a material basis and theoretical direction for further research. Attention was drawn to the requirement of operation at different control levels--manual, mechanical, and electronic--and that the prototype be so constructed as to accommodate any such further technical modifications.

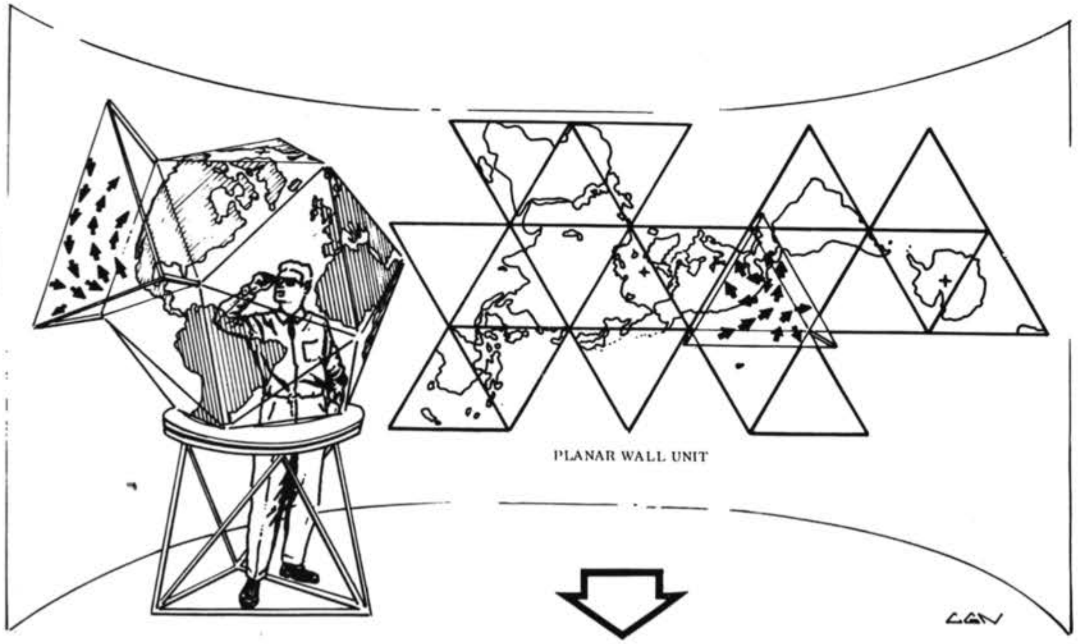
Icosahedron Unit

The Icosahedral form was chosen at this stage as more suitable in time available and to the scale of this particular model for use within restricted school or conference room dimensions. This allowed also direct transference of the Fuller Dymaxion Air Ocean Map projection into the twenty flat planes of the icosahedron for three dimensional or planar viewing.

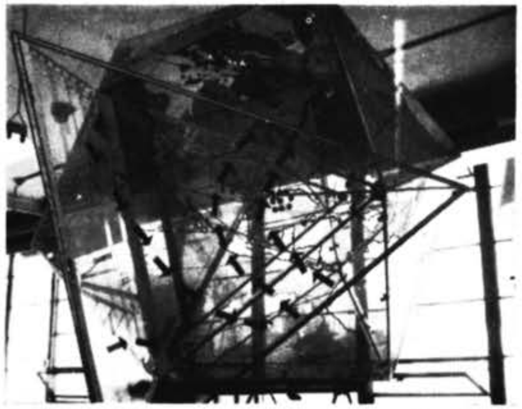
The six foot icosa is made of a light steel tube frame onto which are clipped the double transparent face panels. These face panel units of two triangular Plexiglass



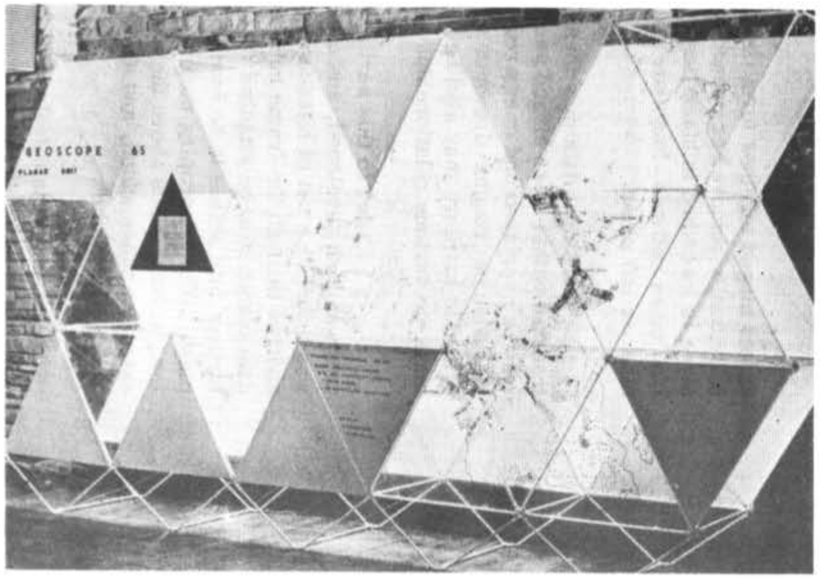
View through tetrahedronal unit



(above) Drawing of Icosahedral unit data planes being viewed from within and planar wall unit in background.



Geoscope, University of Colorado, 1964. Close up view through various data plane levels—from atmospheric wind patterns on the upper level, to air and sea routes and principal cities on the earth plane, and below earth level mineral resources data



Geoscope, planar wall unit, University of Colorado, 1965, Data display: World Population.

sheets hinged together form the basic storage and display unit, each of which may be individually removed or opened for insertion of data (see below). One sheet of the double plane is inscribed in black line with the main world geographical data, i.e., continental land mass outlines, longitude and latitude lines, etc., from the Fuller Projection, the other is left clear.

Additional data may then be stored and presented on thin film (Mylar) transparencies inserted within these hinged panel units. In this way, a considerable amount of information may be overlayed and compared on, and through, the earth surface plane. Such data inserts may also be 'roughs' drawn on any suitable material, i.e., tracing paper. Appropriate erasable markers may also be used on the surface sheet of the panel units to sketch or mark-up various relationships or configurations.

In addition to this earth surface double panel unit, a vertical storage and display unit was also developed, and one such unit was incorporated in the prototype. This unit was based on a set of telescoping tubes which connect at the centre of the icosahedron and run through the frame hubs thus providing a tetrahedronal frame upon which vertical data planes may be attached (based on the double hinged panel principle) and also allows further data planes to be inserted horizontal to, but above and below, the main earth surface plane. The telescoping members extend outwardly from the earth surface hubs and provide for the data planes above the earth surface. Such members may obviously have further extension tubes added, and allow for example scaled staellite tracks to be flexibly located around the 'globe'.

An important feature of this combined vertical and horizontal plane capacity is that it allows for the direct viewing and comparison of many different areas of information. Information on the overall energy exchange cycles above and below the earth's surface may be related to atmospheric layers, temperatures, pressures, earth geological strata, etc. Appropriate cross-sections may be introduced at any level on these planes. Where necessary such cross-sections could be modelled in three dimensions, for specialized studies in geomorphology, hydrology, etc., or ocean floor mapping.

The whole system, as described above, is mounted on a stand so that the user may easily view and manipulate data from both inside and outside the main 'globe', which revolves freely on a circular track under manual control. Similar member and hub units are used in the stand so the complete unit may be economically demounted and packaged for transport with swift reassembly.

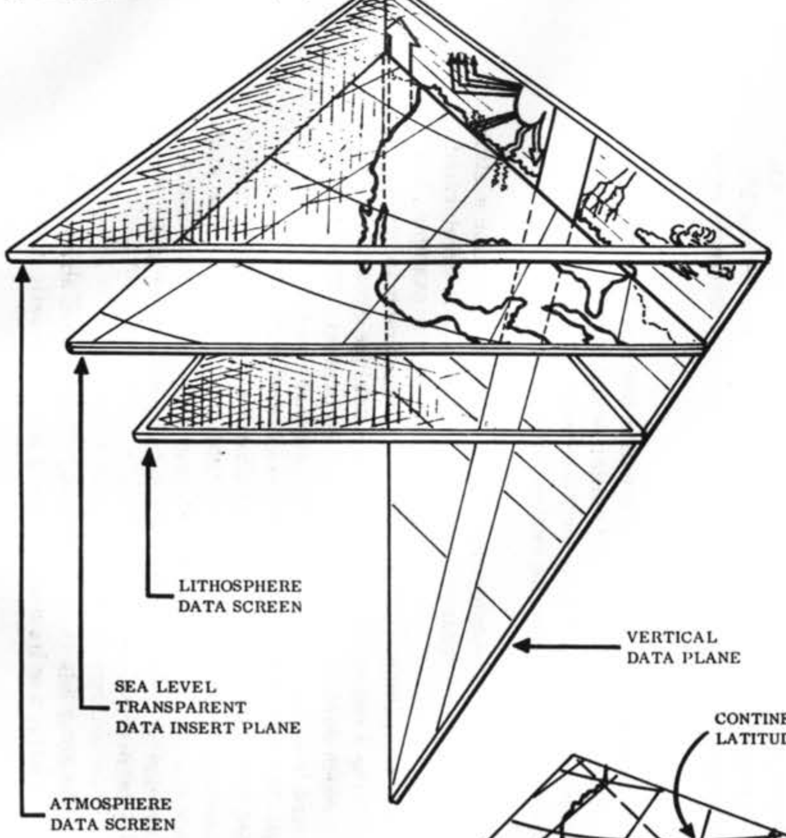
Planar Wall Unit

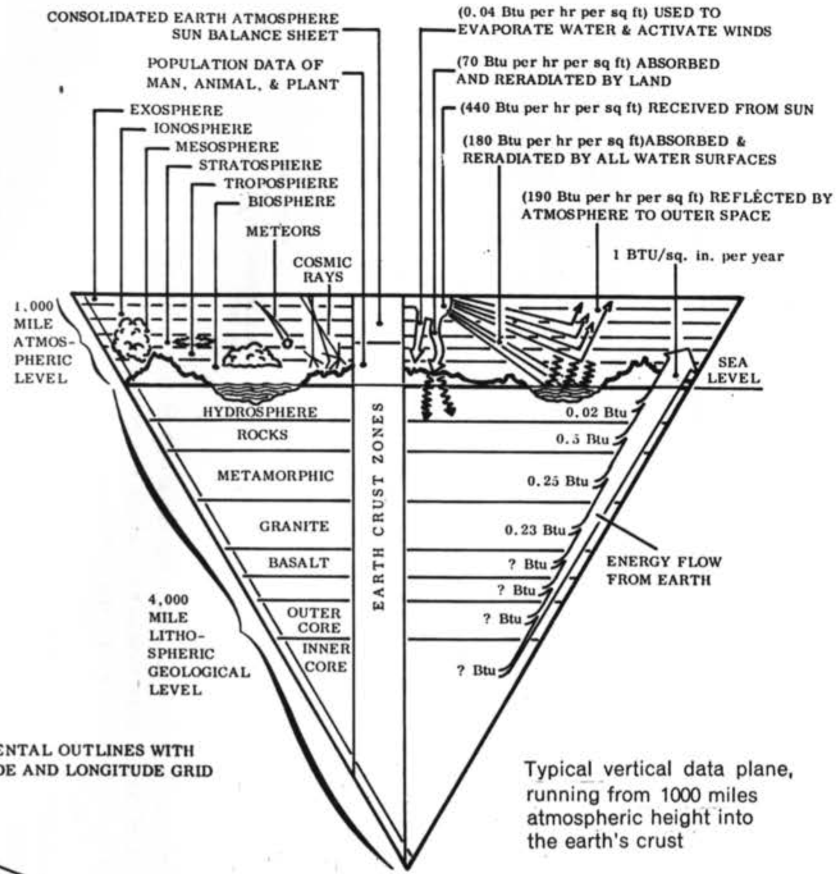
An accompanying wall frame, free-standing, planar display system was also designed, and completed in 1965. This used a similar member/hub construction and the same panel size as the icosahedron.

The same type of detachable hinged panel is used in both units so that data sheets may be transferred from one to the other. The planar unit also allows for storage of such data sheets.

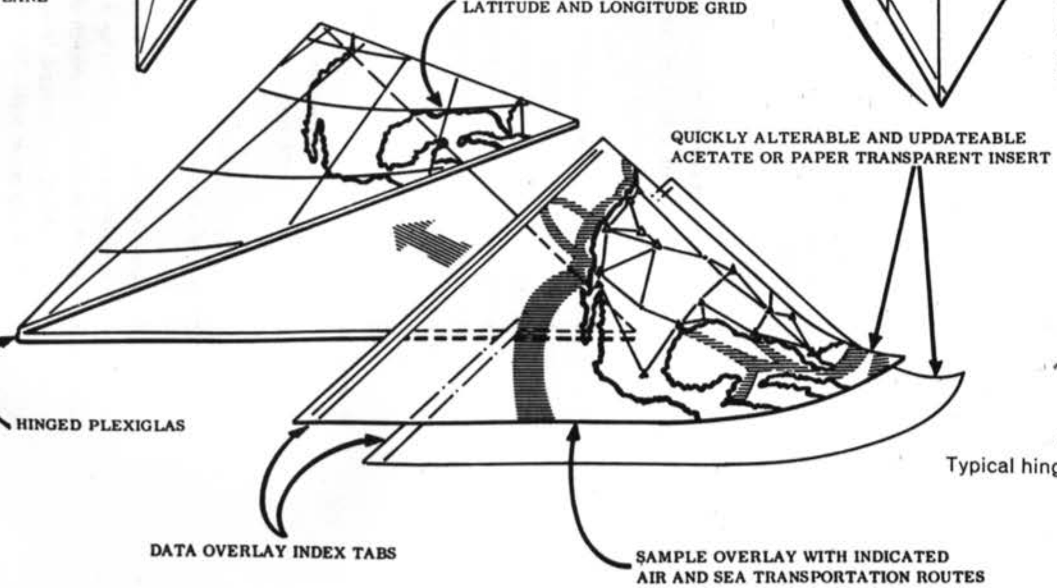
Dimensions of the planar unit are as follows: Nine foot high; sixteen feet long; thirty inches deep. The frame is of 1/2 inch steel tubing with wire tension cables to complete the truss system. Hubs are two inches in diameter steel washers. The transparent triangular display panels are made of two sheets of 1/10 inch plexiglass, and the white faced fill-in panels are 1/20 inch polyester sheet.

Typical tetrahedronal data display





Typical vertical data plane, running from 1000 miles atmospheric height into the earth's crust



Typical hinged display panel and data insert

There are 20 map surface data panels on the unit matching up to the 20 faces of icosa. The depth of the unit was determined -

1) by that necessary to accommodate the tetrahedral insert (to the earth centre) which is shown on the icosa unit, and to give storage space for data insert sheets; and

2) to allow for wiring, projection and other devices for 'dynamic' display purposes.

The approximate weight of both icosa and planar unit crated together for air shipment is approximately 500 pounds.

In order to provide for flexible and swift assembly and use of the hinged panel units, each unit has its own reference number to that portion of the earth's surface which it represents. Each panel edge then has two numbers; one is the panel identification number as above, the other is the panel to be placed adjacent to the edge so identified. To establish a system for coding and reference of the data inserts each sheet has one edge marked with the panel edge code plus content references and legend giving translation of symbols used. Such insert sheets may then, if necessary, be stored in a hinging file and indexed according to this edge marking for access and retrieval. All data planes were similarly edge indexed.

Where edge marking may be critical in obscuring detail as at this prototype scale it may be in the form of a hinged flap. This would also allow the code punching such flaps for rapid random access--as in Keysort or Hollerith Systems.

In further development of this aspect of data control within the system a triangulated reference grid may be employed which would permit correlation between panel data and electronic data processing facilities. By using such a reference grid in relation to the vertical and horizontal cross-section panels any point above, on, or below the earth's surface could be allocated suitable coordinates and data stored on such coordinate code references.

Other possibilities include microfilming of separate data inserts, either singly or in various overlaid arrays, and the swift assembly of smaller scale 'atases' through the print-out facility. The latter device would allow for swift communication of data in immediately usable form between relatively remote centres using the Geoscope system.

Such printed-out data might also be employed as the successive animation sections for the filming of videotape or cinefilm of dynamic trends in accelerated or decelerated review. One such film, for example, has been made under the direction of the author. Using a standard Dymaxion map outline and one dot on this as representing a one million person increment, the growth of world population was charted on the earth surface from 4000 BC to the present. The film was designed within 100 ft. standard length and so ran off 6000 years of population growth in approximately three minutes--30 years per second. This was correlated with main historical events and provided a most dramatic picture of what one may term a 'dynamic trend'. The idea of using standard length and standard methods throughout was that many such documents could be made independently, at various geographically remote centres, of many such trending patterns and be joined together for showing or combined in processing so that such patterns could be related together.

The forward design schedule of this Colorado model, as mentioned above, allows for its further refinement technically, and its use as a basis for the investigation of various mechanical and electronic display and storage systems. From the interest expressed in the University presentation and demonstration of the model, it is planned that such developments may be conducted in collaboration with other departments thus providing a focus for interdisciplinary work at various study levels.

It is also evident that such Geoscope models may function as nuclei for world information centres in universities, schools, libraries, museums, and communities. Within such centres may also be housed, in easily viewable display forms, chartings, and graphic compilations of all such information as would afford the viewer a swift and comprehensive awareness of man in universe. He may thus be able to review and project all past historical and future trending patterns of the human society on earth--the history of invention, of scientific and technological developments, world population and resources, social and cultural trends, the circulation of raw, processed, and scrap materials, etc. These would be conveyed in such a manner as to communicate the sense of their interrelations within various overall ecological development.

No such centres for direct experience and participation in the 'global navigation' of world society have yet been directly developed, though the function exists embryonically in the world's universities, libraries, and institutes, and in its international cooperative agencies and communications networks.

Such facilities, once initiated, might eventually evolve into the beginnings of 'world' universities in the truest sense. The activities necessary for the design, maintenance, servicing, and processing of such facilities would certainly attract and provide for the education and training of world educators of a unique kind. Their necessary grasp of the fundamentally integral patterns of man's accumulated knowledge would enable them to communicate and engender that awareness, or attainment, of a truly 'world view' which is now essential, not only to the further development of human society, but to its basic survival.

N.B. As the furtherance of the World Design Science Decade program rests on individual initiative it is important to identify such individual contributions of personal time and energy whenever possible. The Colorado Geoscope team at the School of Architecture, University of Colorado, is listed below:

NAME	YEAR
Bruce Johnston	5th
Ed Tower	5th
Tim Buck	4th
Steve Day	4th
Wally Kroner	4th
Gage Davis	3rd
Peter Heinemann	3rd
John Orcutt	3rd
Jay Parker	3rd
Eric Klock	2nd
Jerry Smart	2nd
Steve Wisenbaker	2nd
Cal Papritz (Geography Dept. Graduate)	

Coordinating Faculty Member
Professor C. A. Briggs

(No complete listing is available at the time of writing of those individuals responsible for the Nottingham Geoscope and the collaborative work in the various U.K schools.)

THE BIG ALPHABETS (Appendix B)

The growth of man's knowledge, and his structuring of that knowledge into conceptual tools for the understanding and control of his environment, has tended to follow a cyclical pattern of analysis and synthesis--of differentiation and integration. Both are interactive aspects of the whole process, of man's concern with the understanding of the nature of his world.

In science, the discovery of new knowledge is usually described as proceeding from the elucidation of detailed pieces of information, about particular aspects of experience, to their organization and verification in terms of new conceptual hypotheses about larger areas of experience. But, even in science, this method has been somewhat idealized as occurring in such a specifically linear sequence. In many cases, the sequence may be inverted. The discovery of significant detail may attend and be preceded by, what is usually referred to as, an 'intuitive' apprehension of a whole process. Both parts of the cycle obviously feed back upon one another in a way which we do not as yet fully understand.

The trend of scientific development seems presently to favor integration, as evidenced by the fusion of many existing differentiated disciplines into new relationships, i.e., bio-chemistry, psycho-biology, bio-physics, etc.

It appears as if our accumulation of detailed parts-knowledge, due to vastly increased investment in scientific research--has reached a stage when further elucidation of data must be paced, more and more, by the conscious integration of such data into meaningful wholes. This may be necessary simply in order to restore more communication within science itself as a collaborative enterprise. As many of the routine tasks in research, previously performed by human specialists, are increasingly off-loaded through computer assistance, this may occur naturally.

Relative to education, or 'literacy' regarding our present world, it seems essential that we seek to apprehend and communicate our knowledge much more in terms of the larger whole systems. In terms of primary integrative concepts embracing large areas of knowledge:-

> "Concepts are discoveries as well as--indeed more than--inventions....and unifying our thoughts over a vast area of facts....enable certain aspects of the enormous complexity of the world to be handled by men's minds."[1]

In this appendix I have included some of the basic conceptual tools which may be selected from the store of man's present knowledge.[2] Its title, "The Big Alphabets" was used by the distinguished astronomer, Harlow Shapley, to describe some of the main configurations of knowledge which man has put together; his listing is as follows:

A. Elementary and Fundamental: The Letters
Ordinal Numbers
Calendars
Terrestrial and Star Maps

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[1] "The Two Aspects of Science", Sir George Thompson: Science, Vol. 132, Oct. 1960.

[2] See "Omni-Directional Halo" Chapter one and two, Doc. Three, "Comprehensive Thinking" 1965, R. B. Fuller - in the present World Design Science Decade series.

B. The Four Major Summaries:

Energy	-	The Electro Magnetic Spectrum
Matter	-	The Periodic Table of the Elements
Time	-	The Geological Timetable of the Earth
Space	-	The Series of 'Material' Organizations

The following pages contain material on the Four Major Summaries in the above order, plus a diagram on the concept of the Earth Biosphere. These summaries, biosphere, etc., may be usefully related to the charts of the 'Relative Abundance of the Elements-- in Universe, Earth and Man', which were included in our first document in this series; also, to the chronology of the acquisition of the atomic elements (Profile of the Industrial Revolution) in Documents Two and Three.

It is hoped that they may provide an example of the communication of knowledge in a compact and comprehensively oriented manner. As stated earlier:-

> "Time, space, motion, matter, the earth and the life upon it, are the phenomena whose inseparable relationship needs to be convincingly appreciated."[3]

The following conceptual tools are a minimal set of pattern relationships which may enable one to appreciate the overall systematic and orderly behaviors of the earth environment and the universe of which it forms a part. Man is represented here, 'invisibly', as the coordinating intelligence from whose accumulated and ordered universal experience these maps are drawn.

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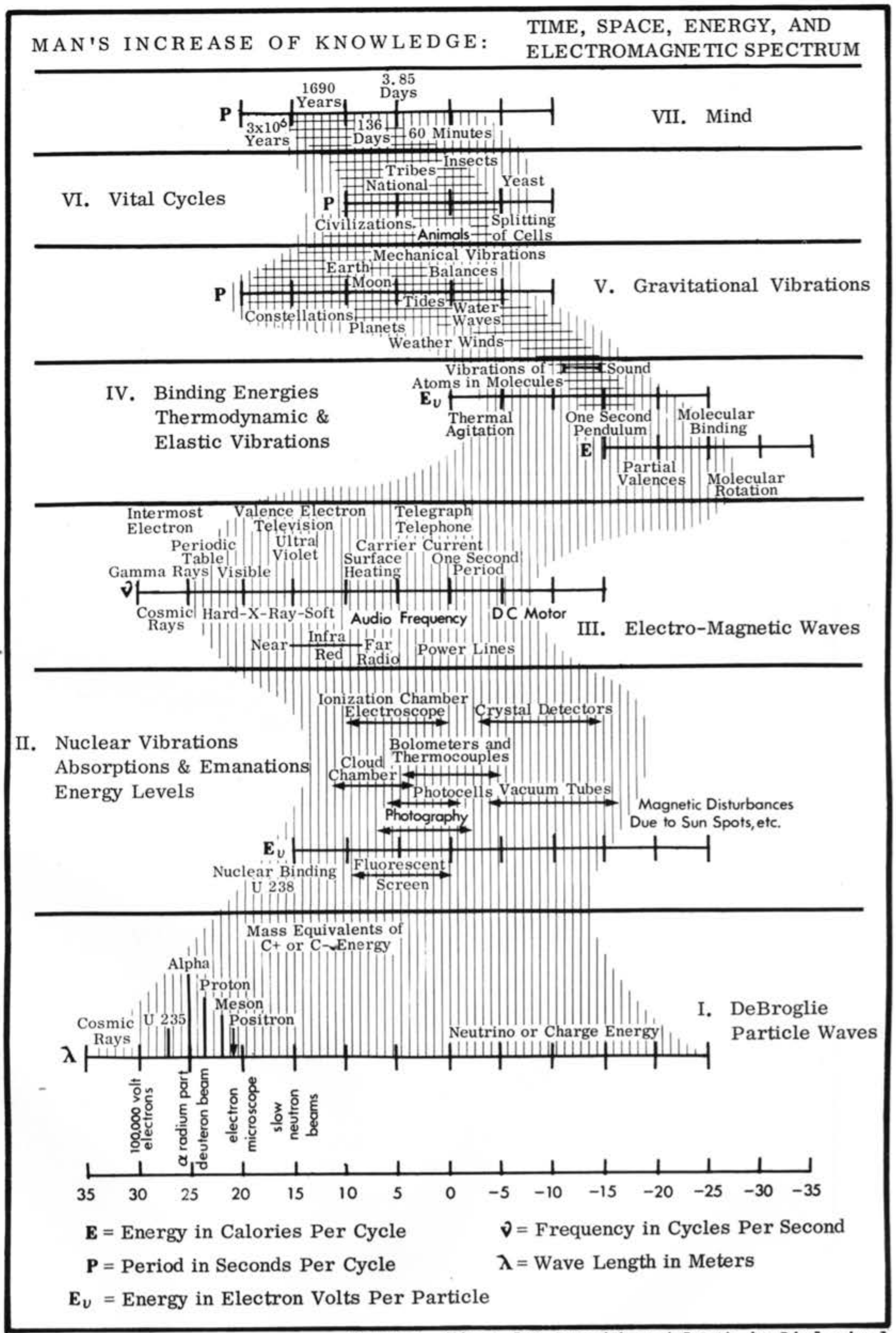
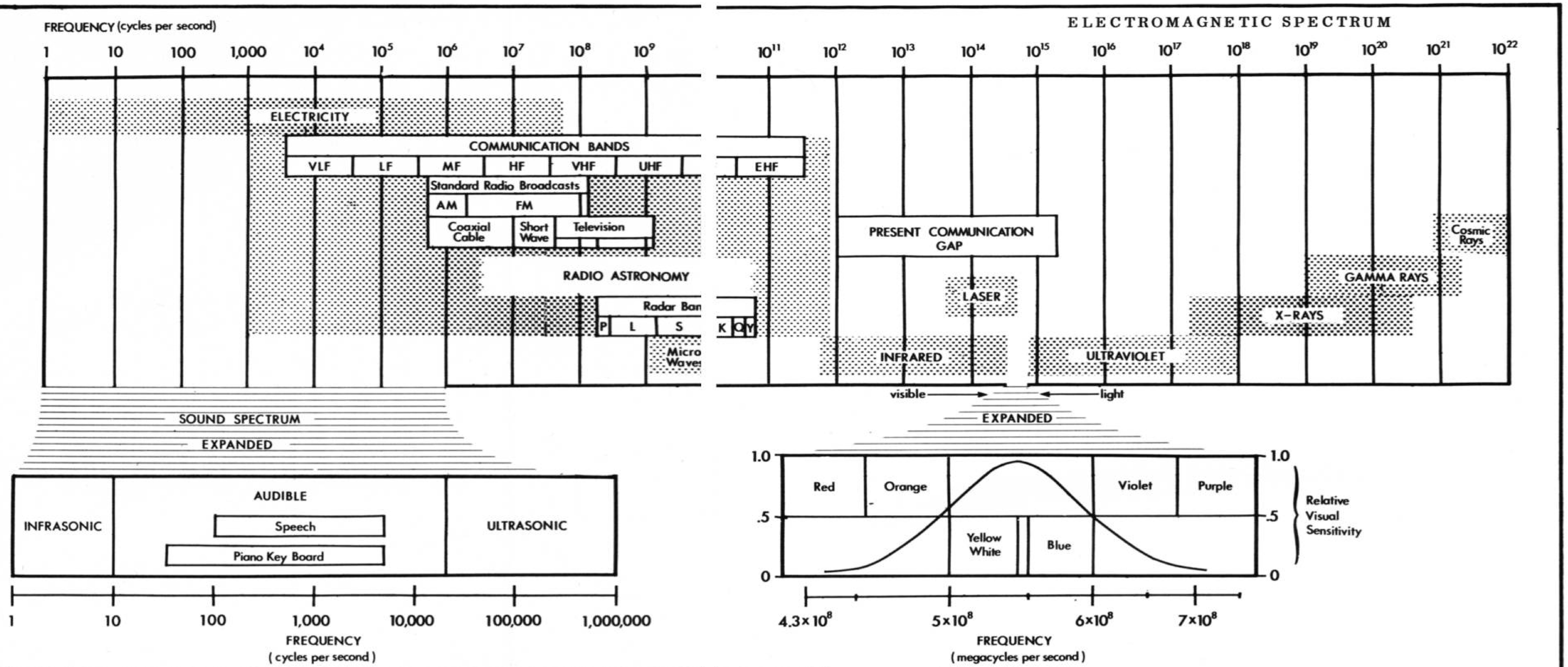
[3] The Perspective of Time, Paul B. Sears, Bulletin of the Atomic Scientists, Vol. XVIII, No. 8, October, 1961.

THE BIG ALPHABETS.

Charts of the Four
Major Summaries, and
the Biosphere.



Source: Time: Its Breadth and Depth in Biological Rhythms. John J. Grebe. Annals of the New York Academy of Sciences, Vol. 98, Article 4, Oct 30, 1962.



(The chart to the left). 'Everything in nature has motion--not just casual motion but moti that is rhyth-mic and unending, following a precise pattern or cycle. If we set a pendulum in motion it not difficult to count the number of strokes, or cycles, in a given period of time. Similarly it is quite sy to observe and time such natural cycles of natural phenomena become greatly faster or slower, or a e phenomena being studied become impossible to observe with man's unaided senses, then we must find her means of observing or calculating these cycles.

Much of all basic scientific knowledge can be encompassed within what man ha arned of these cycles of motion. The darker shaded area on the chart represents the frequencies ervable with man's unaided senses. The lighter shaded area represents the total observable up to e present day through such tools as the microscope, the telescope and all of scientific devices.

Near the periphery are the cycles of the infinitesimal particles within the nucle of the atom whose motion is so rapid that their vibrations per second are reckoned up to 10 to the 23r ower, which, in more unwieldy figures, would be 1 followed by 23 ciphers. Near the center are the mo ents of the stars and planets, some of whose movements are so slow that they may take millions of y s to complete a single cycle.

Those portions of the various scales covering unshaded areas represent the un wn--the yet-to-be-explored frontiers of basic science.' (John J. Grebe: see ref. opp.)

RELATIONSHIP OF MAN TO ELECTROMAGNETIC SPECTRUM

(The chart above). The visual pattern recognition capacity of the eye lens and correlated brain function has been progressively extended and amplified through the simple magnifying lens to the microscope and telescope, through the camera lucida and obscura to the photographic and television camera, and towards sophisticated systems which record, amplify and relate complex visual and aural patterns of great magnitude

This development also encompasses the ways in which man has widened his 'sensorial' monitoring of the electro-magnetic spectrum through instrumentation. He can now 'see' into the infra-red, ultra-violet and Xray frequencies, 'hear' in the radio frequencies, and, may more delicately 'feel' through electronic metering than with his most sensitive skin area.

Sources: (1) "F uency Spectra Chart". Douglas Aircraft Co. Califo a, 1962. (2) "New Techniques of Communication". F.J.D. Taylor. Discovery Magazine, Vol XXV. No. 10, Oct. 1964.

TABLE OF ELEMENTS

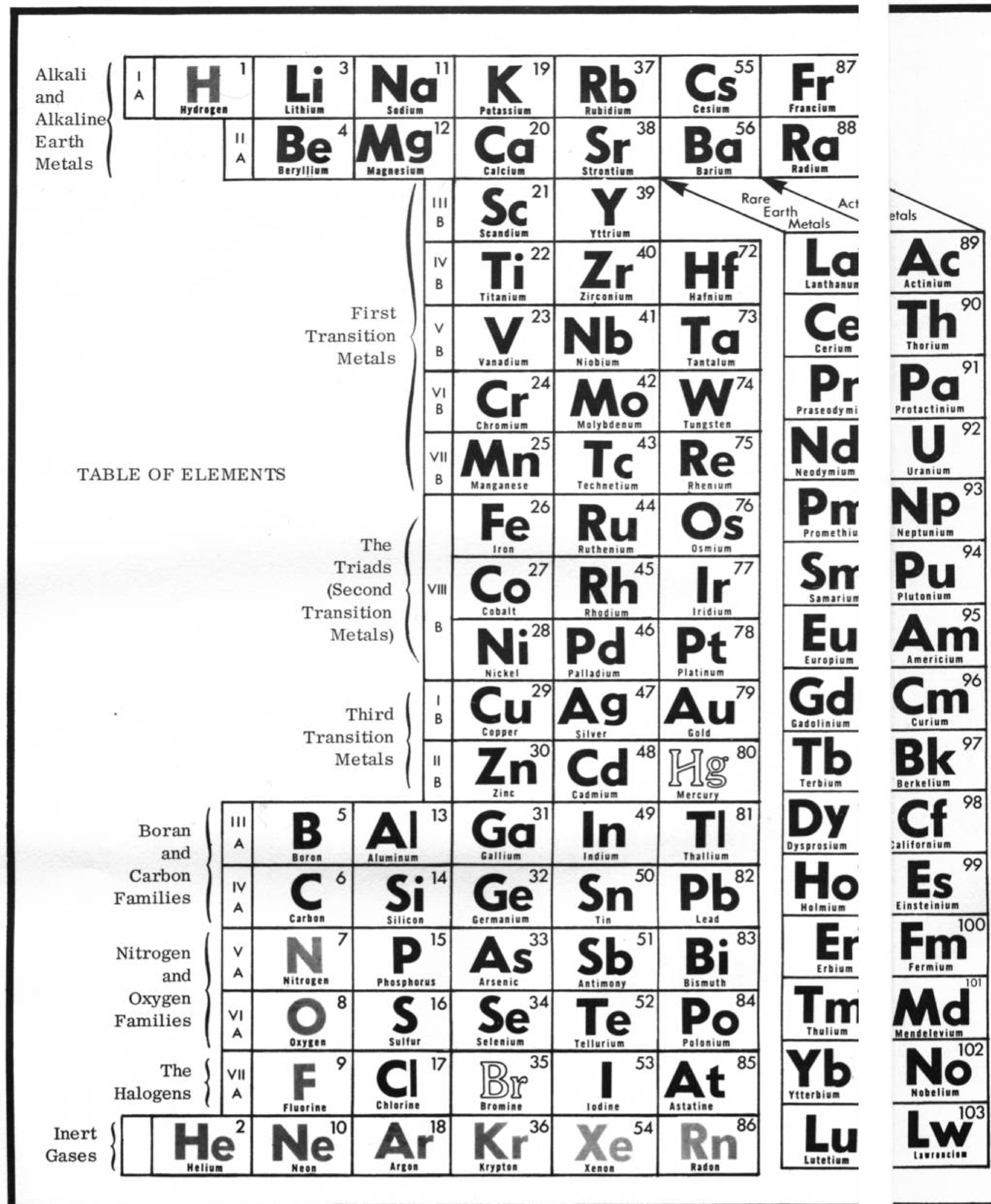


TABLE OF ATOMIC WEIGHTS

#	Atomic weight	#	Atomic weight	#	Atomic weight	#	Atomic weight
1	1.00797	28	58.71	55	132.905	82	207.19
2	4.003	29	63.54	56	137.34	83	208.98
3	6.939	30	65.37	57	138.91	84	(210)
4	9.012	31	69.72	58	140.12	85	(210)
5	10.81	32	72.59	59	140.91	86	(222)
6	12.011	33	74.92	60	144.24	87	(223)
7	14.007	34	78.96	61	(147)	88	(226)
8	15.9994	35	79.909	62	150.35	89	(227)
9	19.00	36	83.80	63	152.0	90	232.04
10	20.183	37	85.47	64	157.25	91	(231)
11	22.990	38	87.62	65	158.92	92	238.03
12	24.31	39	88.905	66	162.50	93	(237)
13	26.98	40	91.22	67	164.93	94	(242)
14	28.09	41	92.91	68	167.26	95	(243)
15	30.974	42	95.94	69	168.93	96	(247)
16	32.064	43	(98)	70	173.04	97	(247)
17	35.453	44	101.1	71	174.97	98	(251)
18	39.948	45	102.905	72	178.49	99	(254)
19	39.102	46	106.4	73	180.95	100	(253)
20	40.08	47	107.870	74	183.85	101	(256)
21	44.96	48	112.40	75	186.2	102	(254)
22	47.90	49	114.82	76	190.2	103	(257)
23	50.94	50	118.69	77	192.2	104	
24	52.00	51	121.75	78	195.09	105	
25	54.94	52	127.60	79	196.97	106	
26	55.85	53	126.90	80	200.59	107	
27	58.93	54	131.30	81	204.37	108	

IMPORTANT ATOMIC CONSTANTS
(physical scale)

Mass of proton (m_p)$=1.0075957 \pm 0.0000010$

Mass of neutron (m_n)$=1.0089861 \pm 0.0000015$

Mass of dueteron (m_d)$=2.0141915 \pm 0.0000028$

Mass of triton (m_t)$=3.016456 \pm 0.000005$

Mass of electron (m_e)$=(5.487675 \pm 0.00004)\times 10^{-4}$
$=(9.1085 \pm 0.0004)\times 10^{-28}$ gm

Electronic charge (e)$=(4.80281 \pm 0.00008)\times 10^{-10}$ esu

Avogadro's number (N)$=(6.0248 \pm 0.0002)\times 10^{23}$ mole^{-1}

Velocity of light in vacuo (c)$=(2.997928 \pm 0.000004)\times 10^{10}$ cm/sec

Faraday ($F=\frac{Ne}{c}$)$=(9652.0 \pm 0.2)$ emu/(gm equivalent)

Planck's constant (h)$=(6.6251 \pm 0.0002)\times 10^{-27}$ erg sec

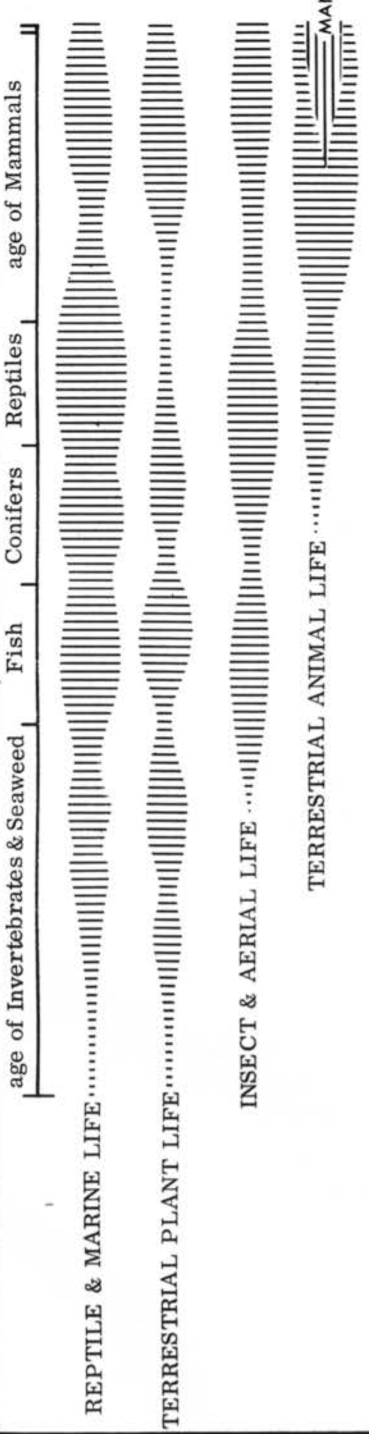
Boltzmann constant (k)$=(1.38046 \pm 0.00005)\times 10^{-16}$ erg/deg

Gas constant per mole (R_o=Nk)$=(8.3170 \pm 0.0001)\times 10^{7}$ erg/mole deg

Adapted from: (1) Periodic Table of the Elements Chart. Central Scientific Co. U.S.A. (2) Life Science Library-matter. Ralph E. Lapp and Life Editors. Time Incorporated, N.Y. 1963.

GEOLOGICAL TIME TABLE

Approximate Chronological Succession of Life Forms on Earth

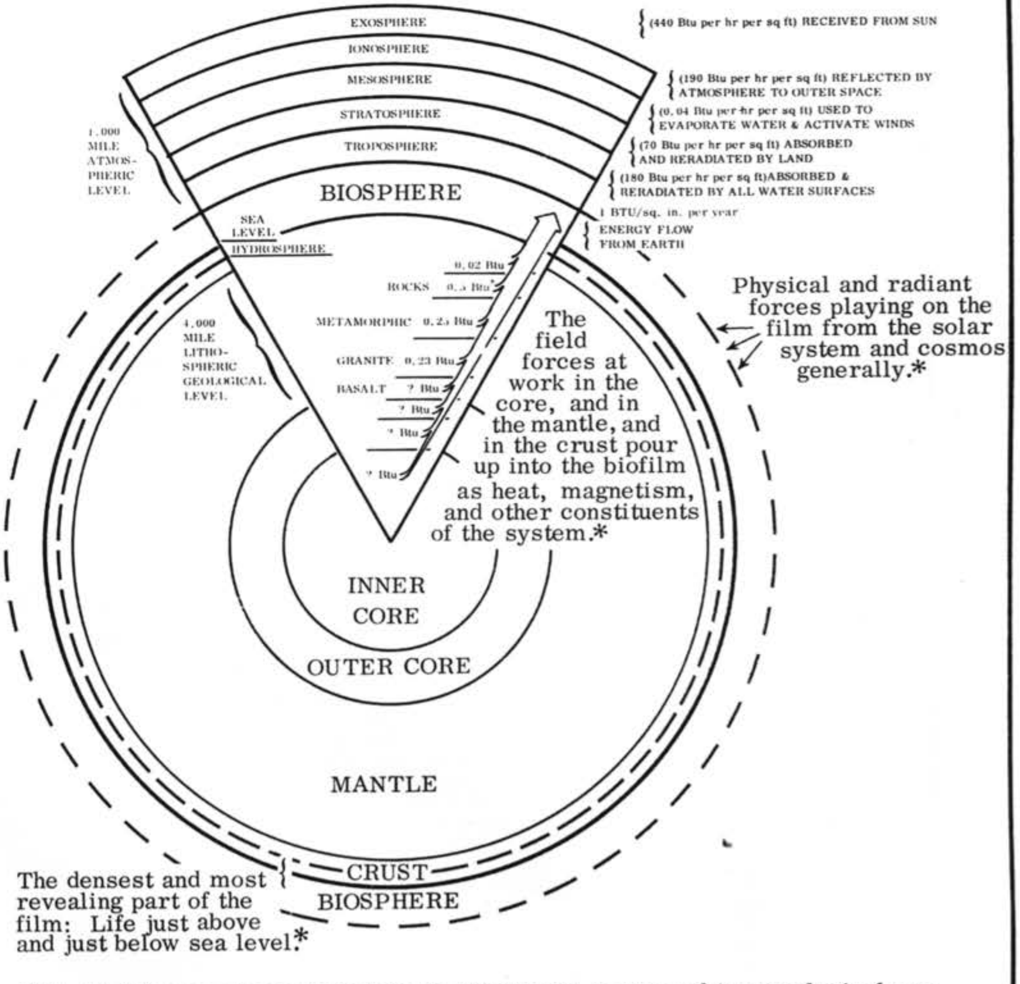


Approximate Duration in years			
ERA	PERIOD	EPOCH	YEARS BEFORE PRESENT
Cenozoic 70,000,000 yrs.	QUATERNARY 1,000,000 yrs.	RECENT	.5 million
		PLEISTOCENE	1 million
	TERTIARY 69×10^6 yrs.	PLIOCENE	14×10^6
		MIOCENE	26×10^6
		OLIGOCENE	36×10^6
		EOCENE	60×10^6
		PALEOCENE	70×10^6
Mesozoic 155×10^6 yrs.	CRETACEOUS 65×10^6 yrs.	late early	135×10^6
	JURASSIC 45×10^6 yrs.	late middle early	180×10^6
	TRIASSIC 45×10^6 yrs.	late middle early	225×10^6
Paleozoic 375,000,000 yrs.	PERMIAN	late early	270×10^6
	CARBONIFEROUS 80×10^6 yrs.	PENNSYLVANIAN	320×10^6
		MISSISSIPPIAN	350×10^6
	DEVONIAN 50×10^6 yrs.	late middle early	400×10^6
	SILURIAN 40×10^6 yrs.	late middle early	440×10^6
	ORDOVICIAN 60×10^6 yrs.	late middle early	500×10^6
	CAMBRIAN 100×10^6 yrs.	late middle early	600×10^6
Proterozoic	PRECAMBRIAN		
Archeozoic			4.5 billion
Azoic	FORMATION of EARTH (current estimate)		6 billion

Sources: (1) 1965 World Almanac. Hansen Editor. New York World-Telegram and the Sun, N.Y. 1965.
(2) World Geo-Graphic Atlas. Bayer. Container Corp. of America. Chicago, Ill. 1953.

EARTH AND THE BIOSPHERE

The biosphere, or biofilm is the thin coating around the earth within which are sustained all the living organisims.



"The biofilm may be regarded as the Continuum expressed in a geological age, an aeon. Just as atoms express the force fields in microcosmic form, so the germ cells may be looked upon as expressing life forces.

A thin slice of reality clothed in physical forms, which obey the laws of force and metric and probably other fields which constitute the hyperdimensional space of nature, non-material and supersensory.

The bio-bubble may be thought of as a dilute gelatinous film of which the living orders actually themselves are the particles held together by physical and by non-material forces. The play of the life drama has gone on for 600 millions of years, the longest continuous performance on the largest screen known to man."*

Adapted from: *(1) "The Film of Living Beauty". F.L. Kunz. Main Currents in Modern Thought. Vol. 18. Sept./Oct. 1961.
(2) "The Geoscope". John McHale. Architectural Design, England. Dec. 1964.

MAN'S INCREASING KNOWLEDGE: SPACE AND TIME

(1) SPACE SCALE OF THE UNIVERSE

Volumes in powers of a minimal unit volume

Volume	Object examples	Linear distances	Diamrs in mrs
150	possible universe (?) spherical "horizon" of knowledge		10^{27}
140	a group of supergalaxies supergalaxy	one billion light years	10^{24}
130	minor group of galaxies large galaxy small galaxy	one megaparsec one million light years	10^{21}
120	galactic satellite cluster globular cluster of stars distance to Regulus	one kiloparsec one thousand light years	10^{18}
110	distance to nearest star multiple star system inner reservoir of comets	one parsec one light year	10^{15}
100	orbit of Pluto orbit of Jupiter orbit of the earth	one billion kilometers	10^{12}
90	outer corona of the sun the sun (an average star) Jupiter (a large planet)	one million kilometers	10^{9}
80	the earth average moon large asteroid	one thousand kilometers	10^{6}
70	medium asteroid or mountain all mankind (a cubic kilometer) great pyramid	one kilometer	10^{3}
60	whale man (a cubic meter) grapefruit	one meter	1
50	cherry grapeseed (a cubic millimeter) flea or grain of sand	one centimeter one millimeter	10^{-3}
40	ovum or dust particle bacterium virus	one micron	10^{-6}
30	protein molecule sugar molecule atom	one millimicron one angstrom (10^{-10}m.)	10^{-9}
20	inner atom	one thousand fermis	10^{-12}
10	atomic nucleus elementary particle	one fermi	10^{-15}
0	possible field entry (?)		10^{-18}

(2) THE SERIES OF MATERIAL ORGANIZATIONS

+9	. . . . . .
+8	Universe (Space time Complex)
+7	Metagalaxy
+6	Galactic Clusters
+5	Galaxies
+4	Stellar Clusters
+3	Star Families
+2	Satellite Systems
+1	Meteoric Associations
0	Man (Colloidal and Crystalline Aggregate)
-1	Molecular Systems
-2	Molecules
-3	Atoms
-4	Corpusiles
-5	. . . . . .

(1) TIME SCALE OF THE UNIVERSE

Duration in seconds	Ages or periods of time
10^{25}	unknown outer limits of time
10^{20}	possible age of the universe (?) age of the earth (6 billion years)
10^{15}	one revolution of the sun around the galaxy age of younger mountain systems duration of human race (a million years)
10^{10}	written history age of a nation a year one revolution of earth around sun
10^{5}	a month a day one rotation of the earth an hour eating of a meal
1	a minute taking of a breath a second a heartbeat a blink of an eye
10^{-5}	vibration period of audible sound a flash of lightning duration of a muon particle
10^{-10}	time for light to cross a room vibration period of radar time for an air molecule to spin once
10^{-15}	vibration period of infra-red radiation vibration period of visible light vibration period of x-rays
10^{-20}	vibration period of gamma rays
10^{-25}	time for a proton to revolve once in the nucleus of an atom unknown inner limits of time

Sources:) Music of the Spheres. G. Murchie. Houghton
ffin Co., 1961.
(2) Lecture Series: Southern Illinois University. Harlow Shapley. 1964.

Phase 2. Review and analysis of world energy resources--differentiation between 'income' and 'capital' energies--design of more efficient energy utilization. Analysis of circulation and scrap recycling of prime metals. Redesign towards comprehensive and more efficient use and reuse 'assemblies' with higher extraction of performance per unit of all invested prime metals in use. (R. B. Fuller, 1964)

Man is, of course, a 'prime mover'--like all living systems--and functions basically as an energy converting organism. Energy is absorbed in one form or another, e.g., food, and transformed for internal and external purposes. Part goes towards maintaining the internal processes of the organism, and part is available for external use, e.g., to find more food. In terms of external mechanical work energies, man is, however, a relatively inefficient energy converter. Operating at less than 20 per cent efficiency, he can only deliver about one horsepower hour of work per day.[30]

His own mechanical energy conversion capacity has been, possibly, the least important factor in his progress. Man's unique evolutionary pattern has been predicated rather as his ability to convert energies externally.

Through his intellectual capacity, he has designed and employed tools which enable him to do this on a much greater scale than may be accomplished solely by his own unaided metabolism. This gain in energy output through the use of technical advantages has increased enormously in the past hundred years, as the conceptual tools provided by the scientific revolution were phased into new technological tools giving higher degrees of energy conversion than were possible for man before. Though many millions of men still function in the lesser developed countries as 'mechanical' energy converters as their own prime source of survival energy, man increasingly functions namely as controller and designer of high energy conversion systems.

It is the type and quantity of energy conversion which sharply distinguishes the highly developed countries from the less advanced. About 80 per cent of the high grade machine energies available are presently preoccupied in maintaining the industrially advanced countries. The lesser developed countries still depend largely for the major part of their work energy on low grade energy converts--animal and human energies converting various agricultural yields through craft tools of various types.

All energy derives from three main sources--one, the radiant energy from the sun; two, the kinetic and potential energy of the earth from the gravitational system; three, energy conducted from the interior of the earth, geothermal energy. All other energy sources are subcycles of these prime sources, and may be divided into 'income' energies and 'capital' energies.

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[30] Cottrell, Fred, Energy and Society, McGraw-Hill Book Co., Inc., N.Y., c1955. Man can convert about 3,500 calories per day. About 20 per cent of this is available for mechanical work--roughly one half to one horsepower hour per day per man.

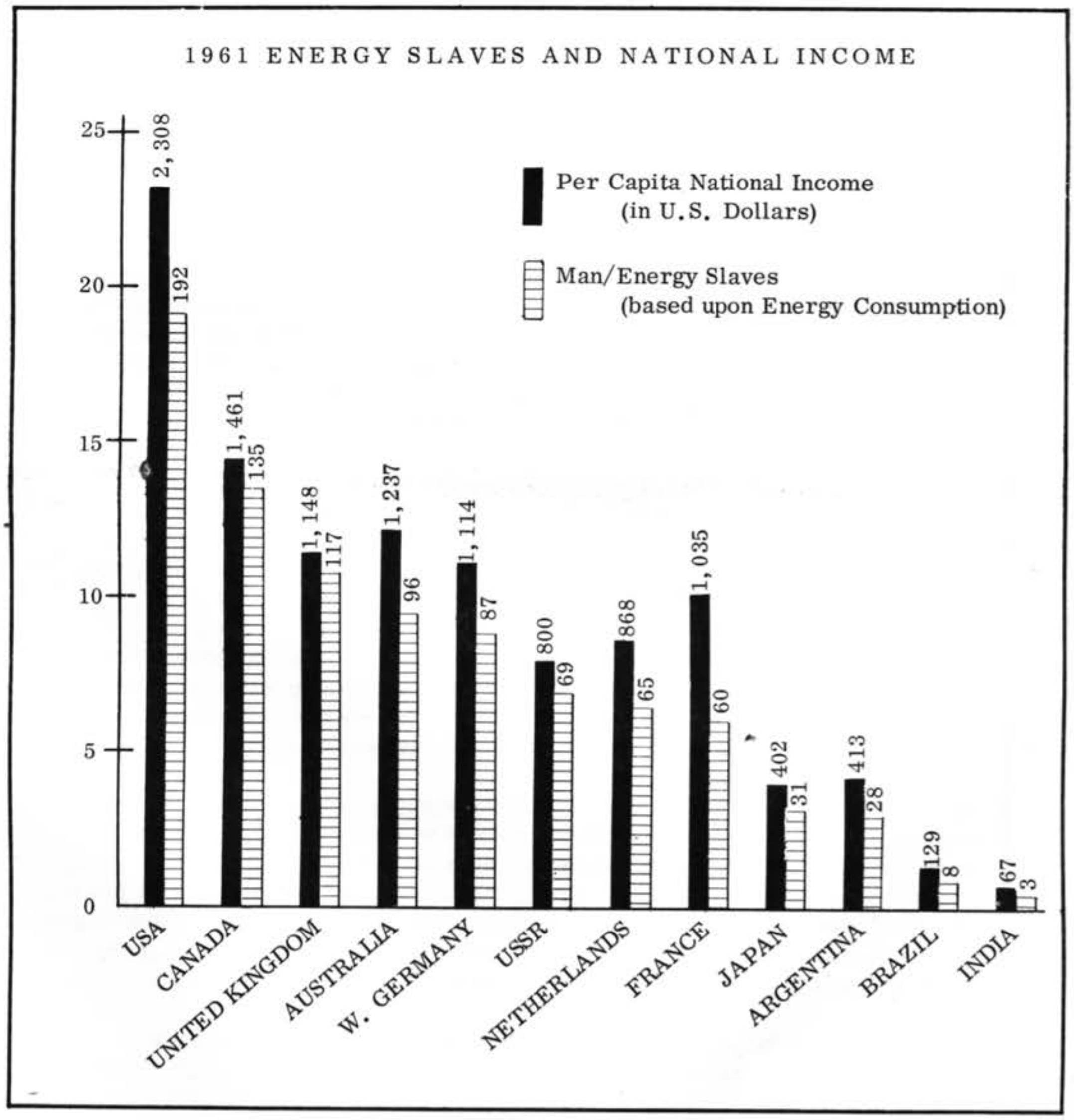
Income energies are those which we may use by converting naturally recurring energies by 'tapping in' to regenerative cycles. Examples of these would be:- one, water power--deriving from the gravitational relation of the earth, sun and moon system--we have the ocean tides and currents; related to this and to the hydrological cycle, there are the rivers as flowing and lakes as impounded income energy sources. Both of these enormous sources are still hardly used. Two, solar energy directly impinging upon the earth--we are just beginning to design means of more efficient conversion of this source for specific purposes; three, wind energy from atmospheric circulation related to earth spin, etc., has long been in use for 'sail' power in ships, through windmills for direct mechanical work and in wind-powered electrical generators; four, geothermal energies--available from hot springs and volcanoes, are, to an extent, income energies, though theoretically they could be used up in time. Little use has been made so far of such sources.

Capital energies are those which may be depleted through use as they are derived mainly from the 'fossil' fuels--coal, oil and natural gas. They are all deposits of solar energy converted by organisms during a 500 million year period of geological time and buried in the earth's crust. Since the onset of the industrial revolution, these energy sources are those which have been, and still are, used most prodigally. Wood is used as a prime energy source, through burning as fuel, in many parts of the world. This is by far the least efficient way of using the stored photosynthetic energy which it represents, particularly in relation to the relatively slow growth cycle through which it may be restored. As it is grown, and therefore, 'regeneratively cycles', one could consider it to be an 'income' source, but its present usage tends to be capital as forests used up are not replaced at the same rate. Nuclear energy, the most recent source becoming available to man, results from two processes - one, the fission of heavy element isotopes in the atomic scale, and two, the fusion of lighter elements. Based mainly on uranium ores in the earth, at present, this could be regarded as a 'capital' energy, but in terms of isotope sources available, and the extension of the process to a wider range of elements, suggest that, in anything but the longest term, this may be referred as an 'income' energy process. It does have, however, at the present time, certain demerits of waste product disposal problems.

If these problems can be dealt with, this may prove to be an extraordinary energy source. Large scale production of power from uranium isotope fission has already been accomplished, and as one ton of rock containing appropriate fission material is equivalent in energy to 150 tons of coal (or 650 barrels of petroleum), this affords man an energy reserve hundreds of times greater than that of his fossil fuels.

As commented upon briefly, the present use of these various energy sources varies enormously. Our current uses tend to favor capital sources and, therefore occasion great concern over the possible depletion of these. Since most of these depletible sources are unequally distributed around the world, access to them, and their control by one nation or another, tends to be the mainspring of many of major international tensions; however, these may be ultimately explained in other terms.

The role of energy consumption available per capita in differentiating between high and low standards of living has been touched on. A full analysis of the world energy population distribution in these terms will be found in Document One in this series. Eighty-eight per cent of the world's energy is presently consumed by less than half of the world's population. Of that eighty-eight per cent representing high grade industrial energy conversion, approximately forty-seven per cent is solid fuels, thirty per cent liquid fuels, fifteen per cent natural gas and about eight per cent only is hydro-electric power representing use of 'human' energy. The location of ninety per cent of the proved and estimated fossil fuel sources are as follows:



Source: Energy and Economic Growth. Haig Babian. N.Y. University, 1964.

Coal	- U.S.A. (35%); U.S.S.R. and China (50%); Europe (13%). The three continents of Africa, South America and Australia share the remaining 2%.
Oil	- Middle East (60%); U.S.A. (13%); U.S.S.R. and China (11%); South America (8%) Africa (3%); Others (5%).
Natural Gas	- North America, Middle East, U.S.S.R., North Africa and Netherlands.[31]

Estimates of natural gas reserves vary considerably, as do coal and oil reserve estimates over the years. We do not know, with any real certainty, how much we have of these reserves or how far we can rely upon them in the future.

In terms of rendering world resources adequate to the service of all men, it is interesting to speculate that if we were simply to extend our present rate of consumption of energy at the present level and efficiency, in the highly developed countries this would mean an approximate 40 per cent rise in our present consumption of fossil fuel reserves. The latest estimate of such reserve exhaustion at a four per cent annual rise is given at 120 years. By simple sharing we would possibly reach the end of such fuels in 12 years!

In view of the amount of atmospheric contamination and other types of pollution involved in the use of fossil fuels, authorities have suggested that serious consideration be given to a planned world shift to other energy sources. In the lay term sense, apart from the obvious depletion of irreplaceable fossil fuel reserves which could then be kept in emergency store, this seems the wiser comprehensive solution.

Our available 'continuous' or income energy sources have much greater potential with much less hazard. They also have much greater flexibility in, for example, producing electrical power directly which may be easily transformed, specially transmitted over great distances and meets the largest number of varying power needs.

It has been calculated, for example, that if the world water power, were fully developed, the electrical energy produced per year would be equivalent to six times our electrical power production in 1959--to produce this amount of energy would require about ten times our present coal production.[32] Realizing the full use of the world's water power energies would redraw the world energy map to quite an extent, e.g., Africa has the largest power resources and South America the second largest of the continents. Solar energy, tidal and geothermal capacities are still relatively untouched.

Of course, the key to the use of resources are the tools to convert them to required purposes. Energy of the types reviewed was always available, but high conversion rate tooling has only recently become so. The development of technical efficiency in

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[31] Energy Resources: Publication 1000 D. National Academic Sciences, Wash., D.C. 1962. Fuel and Power in 1984: Sir H. Hartley FRS, New Scientist (Eng.), May, 1964.

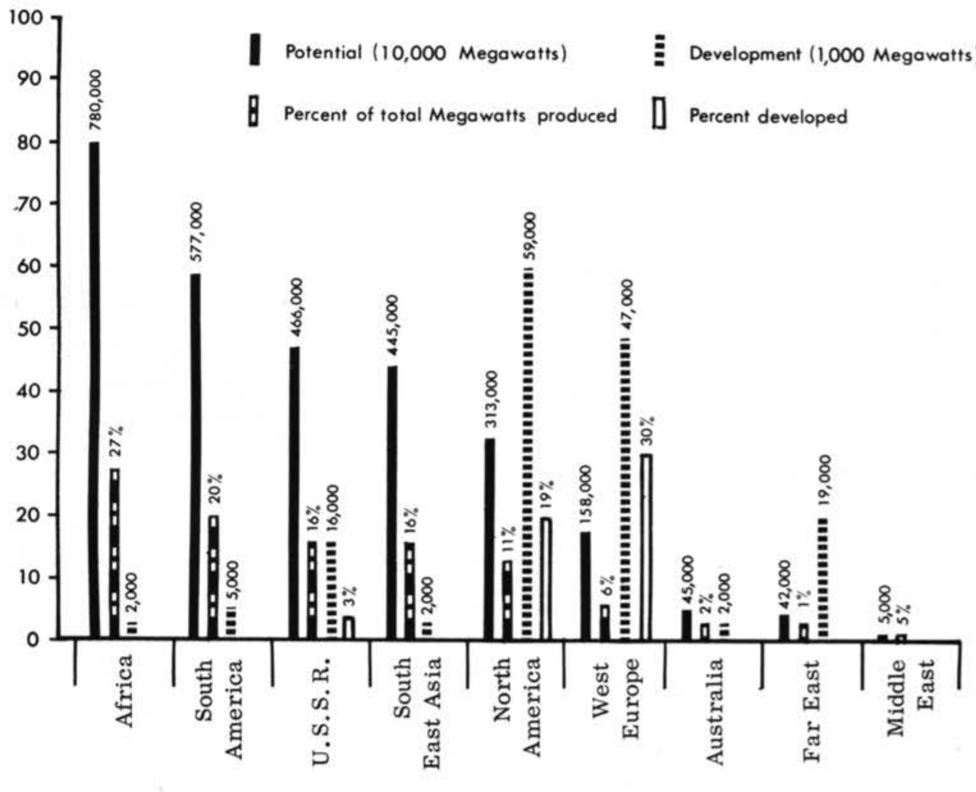
[32] Energy Resources: Publication 1000 D, New Academic Sciences, Wash., D.C., 1962.

1950 POPULATION, INCOME, AND CONSUMED ENERGY

area	population in millions	income per capita	energy consumed per capita (kw-hrs.)
World	2,497	223	1,676
Africa	199	75	686
North and Central America	219	1,100	10,074
South America	112	170	741
Asia	1,380	50	286
Europe	393	380	3,117
U.S.S.R.	181	310	1,873
Oceania	13	560	3,543

Source: The Population Crisis and the Use of World Resources. Ed. by Stuart Mudd. (p. 109 Demographic Dimensions of World Politics, by P.M. Hauser) World Academy of Art and Science, 1964.

WORLD WATER POWER CAPACITY



Source: Conference on Energy Resources. Frances L. Adams. Committee on Natural Resources, National Academy of Science, N.Y. 1961.

high energy converters belongs more properly in our Tool Evolution phase, but some mention may be pertinent here. Modern power begins with Watt's modification of the Savery-Newcomen Steam Engine. This might well be studied as a prototype example of design invention of the type with which we are engaged. Finding the Newcomen again wasteful of fuel, Watt redesigned this so as to extract three times as much work from the same input! Still the Watt steam engine had a technical efficiency below five per cent. Parallel in development to the steam engine, but of later date, the steam turbines produced, for example, forth to fifty times as much energy per unit of coal as the Newcomen engine. Modern steam turbines are now around 40 per cent efficient. The present range of energy conversion efficiency available to us at present 'prime mover' design levels, are roughly as follows:

Steam Locomotive	7%
Automobile engine	10 - 15%
Reciprocating aero engine	23%
Turbo (at 40,000 feet)	24%
Ram jet (at 1,300 mph)	21%
Gas (general)	30%
Diesel locomotive	35%
Electrical Generating Steam Turbines	40%
Fuel Cells (potential)	80%
Hydro-electric turbines (water wheel)	90%

Apart from consideration of specific area efficiencies worked out on total machine plants' processing world energy is presently used at a very low overall efficiency rate. At best only 20 per cent of the energy in the world's full consumption is utilized! The recent World Power Conference, held in September, 1964, had as its main theme, "Ways of Redesigning to Combat this 80 per cent Loss of Energy."[33]

Such redesign for higher performance per unit of invested energy is mandatory if we are to attempt to raise world living standards and represents a key direction for the 'extension' of even present resource use to all.

A prime example of higher energy performance towards greater service is discussed in Buckminster Fuller's 'Geosocial Revolution',[34] the development of ultra-high voltage; UHV electrical transmission now render economically possible great intercontinental linkages from relatively isolated generating sources at vastly decreased auxilary energy transport inputs. Africa and China could be the world's main energy producing and transmitting sources within a not too distant period!

Apart from the large scale engineering of such high performance gains, our program should concern itself with the comprehensive review and correlation of the fuel of energy conversion discoveries which are being made available through rapidly advancing science and technologies in this area. At the present stage of knowledge accumulation and specialization barriers, such discoveries are often mislaid despite the efforts of governments, industries and other agencies to maximize their economic advantage. (Many so-called, unconventional energy sources and conversion capacities belong in this category.)

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[33] "The Times", London, Eng., Sept. 9, 1964.

[34] Document Three (1965), "Comprehensive Thinking", R. B. Fuller.

1950 POPULATION, INCOME, AND CONSUMED ENERGY

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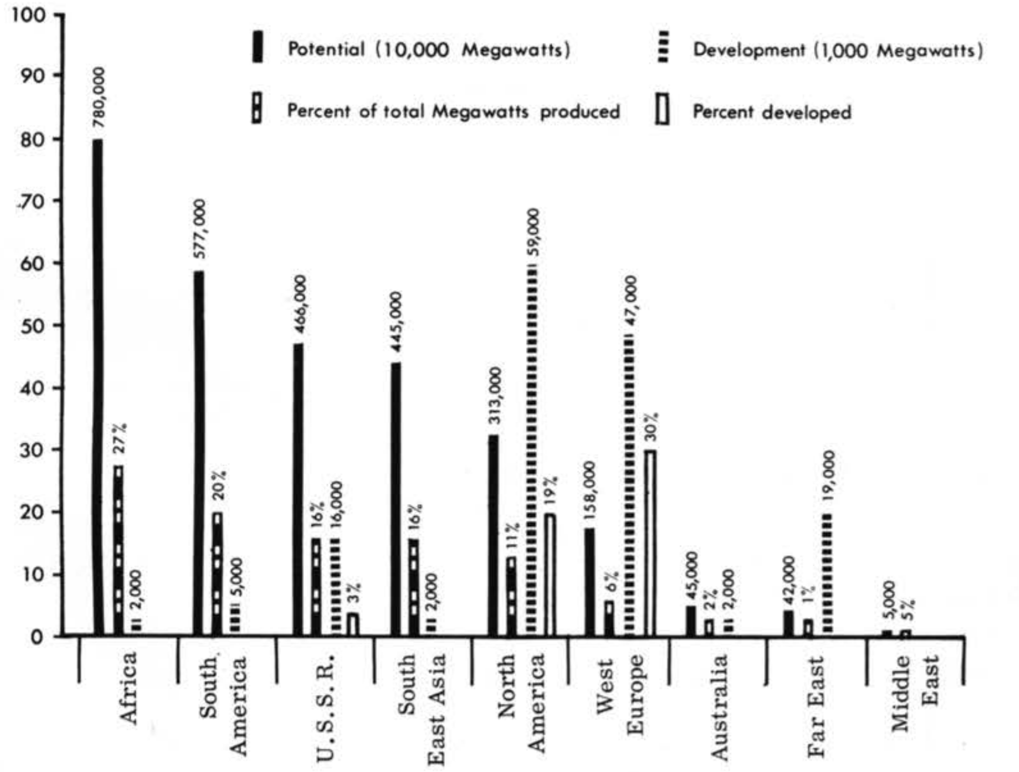
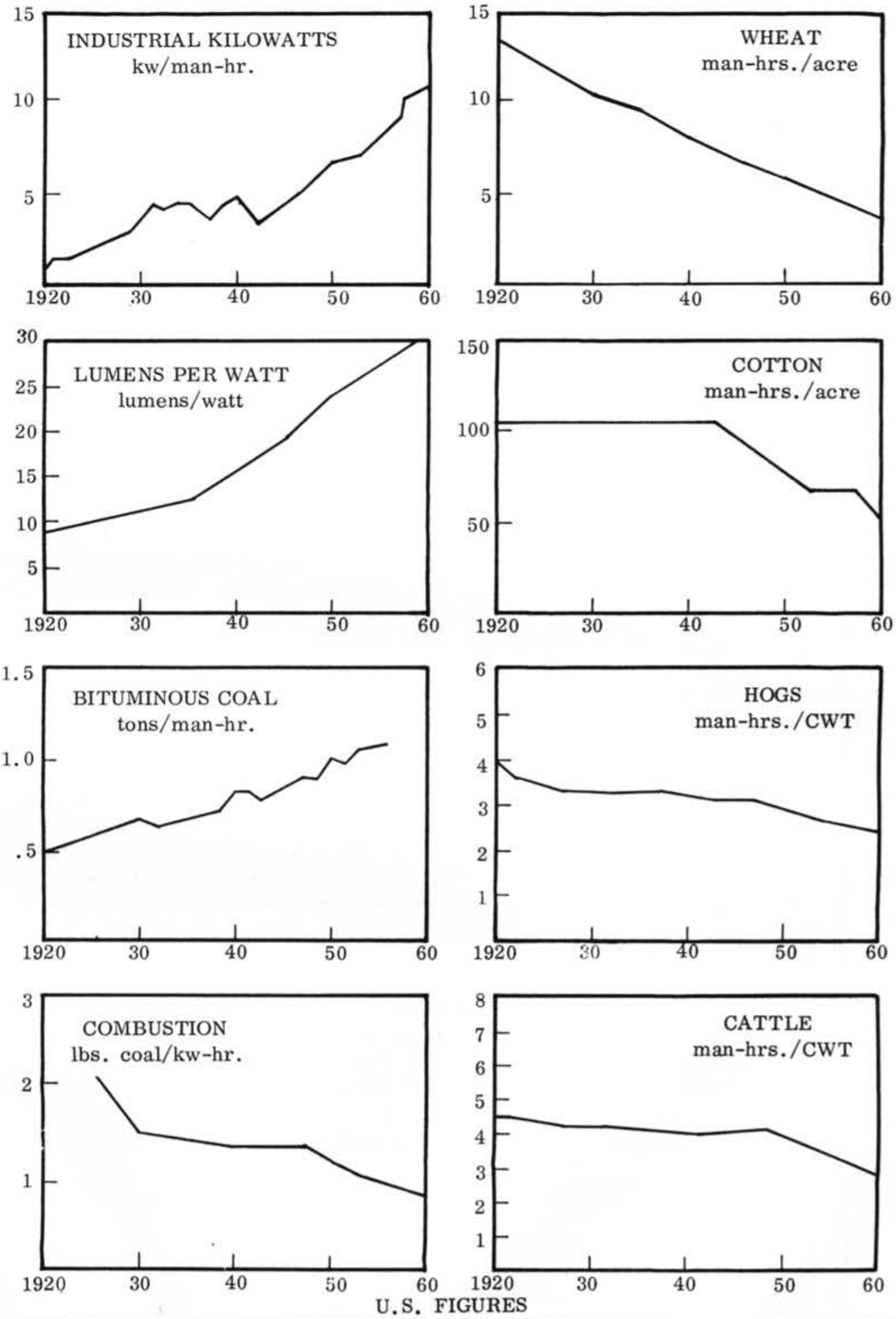
Source: The Population Crisis and the Use of World Resources. Ed. by Stuart Mudd. (p. 109 Demographic Dimensions of World Politics, by P.M. Hauser) World Academy of Art and Science, 1964.

WORLD WATER POWER CAPACITY



Source: Conference on Energy Resources. Frances L. Adams. Committee on Natural Resources, National Academy of Science, N.Y. 1961.

PERFORMANCE PER ENERGY UNIT INVESTED



U.S. FIGURES

Based on: Chart series of R.B. Fuller. Fortune Magazine, Feb, 1940.

Among recent space technology developments, for example, was a fuel cell unit weighing one-fifth of an ounce and producing two watts of electricity. In developing fuel cells for the Gemini spacecraft, a similar energy unit was reported which weighed less than a man, yet replaced a ton of batteries and could produce drinking water as well. Fuel cell-driven surface vehicles have already been built.

Portable gas turbin generators with remarkable power to size ratio, developed initially for aircraft use, are now available and deliver comparable power for a diesel engine four times their size. With per capita garbage output averaging from 500 to 1,000 pounds per day in advanced countries, German engineers have evolved a 'clean fume' incinerator which gives high power output as an auxilary power station. Experiments in bio-electricity using the organisms' own potential to power artificial arms, legs, etc., are proving successful, and in the same area considerable work has also been done in 'microbial' fuel cells in which micro-organisms generate electrical energy in their food processing.

Such examples might be extended for many pages. A program of development such as we are planning depends closely on comprehensive review of material of this nature, and the maintenance of 'efficiency-rated' inventories of all high performance technologies appropriate to various environ control requirements. Students should keep trend charts of energy conversion efficiencies in various fields and cross relate such developments against average requirements and possible performance augmentation in other areas.

Considerable insight into overall energy efficiencies may be afforded by the analysis of those operable in 'house' as a major environmental control. The industrial energy conversion components for heating, lighting, cooking, etc., presently incorporated in 'high standard' dwellings are technologically far in advance of the enclosing 'shell'. The advance in housing standards has been achieved almost entirely through the introduction of such mechanical services and is reflected in the relative costs invested in shell and mechanics. In 1900 such costs were approximately 97 per cent for shell and 3 per cent for mechanics--today this is closer to 50 per cent each way. The dependence of 'house' services on local input/output through power lines, piping, sewers, garbage service, etc., is one of the largest 'hidden' costs of housing. Their piecemeal unrelated function also downgrades the overall performance of the system. The 'Universal Requirements' schedule of R.B. Fuller[35] may be used as a guide here in such studies as:- <u>one</u>, overall systems analysis or energy flow sheet, of present conventional operation; <u>two</u>, redesign of the system towards maximal performance; <u>three</u>, redesign of individual components toward coupling of services into a fully linked integral system giving maximal performance for energy invested.

On larger scale environment control systems the same comments may be made. Little overall systems analysis has been accorded multiple dwelling units, and even less attention has been given to the operation of the whole 'services' system at the larger community level. Thence to the overall input/output energy accounting for regional and larger systems.

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[35] Document Two (1964), "The Design Initiative".

Prime Metals

The use of energy and the development of high performance energy conversion is tied closely to the development of metallurgy and the availability of large supplies of the prime metals.

Iron and steel constitute about 95 per cent of the world's metal production. The non-ferrous metals closely associated with steel production, i.e., through use in alloying to give special mechanical or physical properties, are vanadium, molybdenum, manganese, tungsten, chromium and cobalt.

Five other main metals, not directly dependent on steel technology are copper, lead, zinc, tin and aluminum. Among these, copper production and use is a sensitive barometer of technological and industrial change through its efficiency as an electrical conductor, its ductibility, alloying properties, etc.[36]

Such division, of course, tends to be somewhat arbitrary and related specifically to current uses and technologies which are in process of constant change. The so-called 'rare' metals, for example, have come into increasing prominence and importance recently, both as extraction and isolation technics improve and as the demand for their particular characteristics emerges, i.e., in space technology. Many of the 'rare' metals are included above, others are titanium, beryllium, mercury, antimony, tantalum, columbium, etc.

As with all major resources necessary to the maintenance of industrial civilization, the large metal ore reserves are distributed inequally around the earth. No one country is wholly self-sufficient in the full inventory of metals required to sustain advanced industrial processes. Document One (1963) is our series contained a charting of forty major metals and minerals production for most of the countries in the world. Noted relative to this was the present and past patterns of world tension associated with the control of seemingly backward and valueless areas which, on inspection, turn out to be key sources for various major metals or minerals.

The production and overall reserve picture is, however, not as critical as it may seem. One factor which changes the actual natural resource location is the progressive recycling of metals, the scrapping and re-use cycle which constantly increases and re-distributes the metals in our above ground 'mines' as industrial development tends to do more with less in each successive use. The second factor is the increasing capacity to process ores of decreasing metal content at less energy input cost.

Scrap metal now accounts for over half the input into iron and steel production plants. Conservative sources suggest that 60 per cent of the copper in use is now re-coverable, and, since three quarters of all the known consumption of copper has occurred since 1900, scrap copper recovery would be about one million tons per year and would then constitute about one half the total available supply of copper. Though reducing the 'critical' aspects of the overall resource position, etc., this still leaves our major task unfulfilled as the consumption of metals per capita goes higher, then more and more specific design attention will have to be paid to increased overall performances per pound of metal used--even to maintain the present disparity in living standards. A key factor, as has been reiterated, in raising the general world living standard is, therefore, the tripling or quadrupling of the performance of metals in use.

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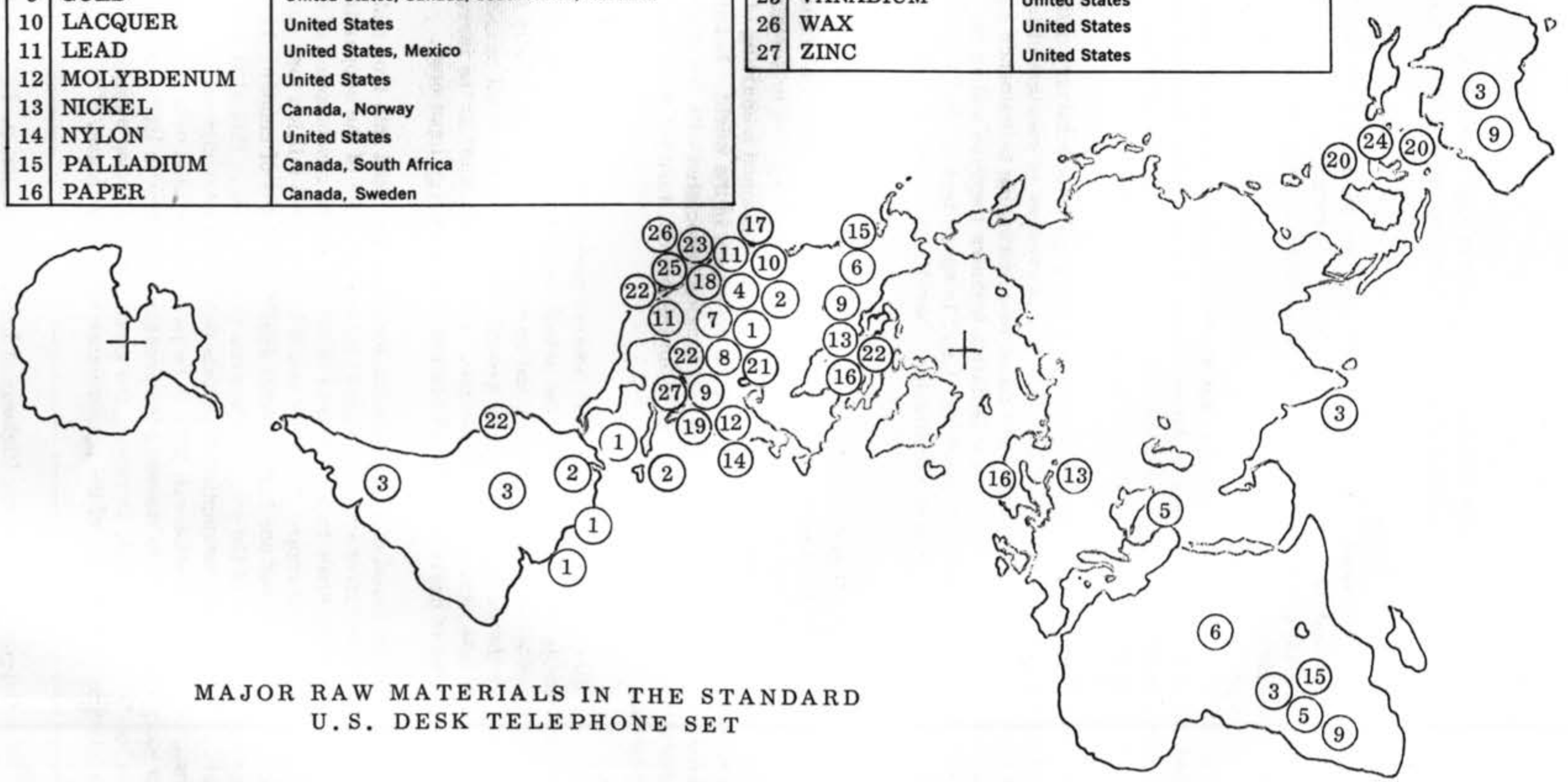
[36] See Copper: The Energy Highway of Industrialization, p. 125, Document Two, 1964.

	RAW MATERIAL	SOURCE LOCATION
1	ALUMINUM	United States, British Guiana, Dutch Guiana, Jamaica
2	ASPHALT	United States, Venezuela, British West Indies
3	BERYLLIUM	Brazil, Argentina, India, South Africa, Australia
4	CARBON	United States
5	CHROMIUM	Turkey, South Africa
6	COBALT	Republic of Congo, Canada
7	COPPER	United States
8	COTTON	United States
9	GOLD	United States, Canada, South Africa, Australia
10	LACQUER	United States
11	LEAD	United States, Mexico
12	MOLYBDENUM	United States
13	NICKEL	Canada, Norway
14	NYLON	United States
15	PALLADIUM	Canada, South Africa
16	PAPER	Canada, Sweden

	RAW MATERIAL	SOURCE LOCATION
17	PHOSPHORUS	United States
18	PLASTICS	United States
19	RAYON	United States
20	RUBBER	Indonesia, Malaya
21	SILICON	United States
22	SILVER	United States, Canada, Peru, Mexico
23	STEEL	United States
24	TIN	Indonesia, Malaya
25	VANADIUM	United States
26	WAX	United States
27	ZINC	United States



MAJOR RAW MATERIALS IN THE STANDARD
U.S. DESK TELEPHONE SET

Source: Western Electric Co., Inc. Sept. 1963.

In relation to the large scale planning of the 'metal economy', it is worth noting that steel, so far accorded first priority in such planning, may not always retain its prime place. Apart from the fact that through improved transportation, etc., countries are no longer dependent on their locally available raw material resource, or confined to a particular technological development process, there is also the progress in light metals, composites and plastic technologies which have displaced steel as prime requirements in many areas.[37] "Steel is losing its historic role as the symbol of economic potency" as it is replaced by the light metals, structural composite materials and plastics.[38] For example, in automobile production, plastics used per car doubled between 1954 and 1960, and the aluminum is expected to triple or replace steel as the main metal in the near future.[39] Within the steel industry itself this leads to the increased performance development of stronger and lighter steel alloys. In general, the displacement of many of our traditional 'key' materials through more efficient substitutes and replacements requiring less weight and energy processing is proceeding at a considerable rate. The copper 'trending' referred to above gives some insight into this process where aluminum replaced copper in high tension electrical lines--though not as good a conductor, aluminum's weightsaving allowed support towers to be more widely spaced, thus giving an accompanying performance economy in steel used.

Various other developments affect this changing metals use picture also. Progressive weight saving, overall performance gains and reduction in maintenance energy are being affected to an astonishing degree in the sub and micro-miniaturization of components in the space and communications industry.[40] Composite materials, i.e., 'powdered' and sintered metal/mineral alloys, are coming to play an increasingly important role in space materials, as well as new methods of 'filament-wound' structures which give great strength-to-weight ratio advantage. Molecular engineering--the designing and restructuring of materials to any prescribed range of properties--is advancing to the point where we may order a 'metal' or metallic composite with the combination of precise performance criteria required. To the resource reserve, we may now add the availability of metals discovered as accumulating in large nodular deposits on the ocean bed--these are estimated to contain 25 to 30 per cent of manganese, 1 per cent of cobalt, copper and nickel plus other metals in varying proportion.[41] These may be available in the next ten or twenty years. Off shore dredging of continental shelf sands for magnetite, tin and other ores is already in process.

Despite these increasing capacities, it is essential to bear in mind that the overall consumption and amortization of metals in varying use cycles is still increasing also. The newer capacities, if incorporated within the present distribution and use patterns, will only further increase the discrepancy of living standards in the world. Our task still remains to integrate and implement these capacities in high performance use--assemblies so as to render all resources adequate to the service of all men.

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37 e.g.: Development of the Steel Industry in Japan

38 "Technology and Economic Development": Scientific American, Sept., 1963.

39 "The Challenge of Abundance": Theobald, Mentor, 1961.

40 "Tool Evolution", Chapter for further discussion of this area

41 "The Research Frontier", Roger Revelle, Saturday Review, Oct. 3, 1964.

In redesigning towards comprehensive and more efficient use and reuse 'assemblies' with higher extraction of performance per unit of invested metals, it will be necessary to study these in ways not customarily thought of. For example, in designing a large scale miltiple dwelling environment control though much thought is applied to the ease and efficiency of construction, i.e., to the energy required to build the unit or units, little thought is given to that required to dismantle them. We still tend to build permanently even though the use-cycle of many such systems grows steadily shorter. In our designs, therefore, we should include the energy inputs and materials 'wastage', etc., to be incurred in the dismantling of such structures when they are no longer needed.

The design scientist must think beyond the 'static' assembling of the 'end product' of the unit, as designed, built, and used to its place in a regenerative changing of usage cycle, not only of materials, but of requirements. We are required to design not only for use but also for reuse. Our urban centers, for example, are clogged with obsolete buildings whose dismantling costs prohibit their removal. The new environmental control systems will not be 'end products' in this manner, but will be subject, like aircraft, to progressive obsolescence and redesign as technological capacities develop, and as changing social needs require them to change in many ways to man's own changing requirements. If we need cities they will be expendable, expandable and swiftly alterable to the full requirements of their users. There are no final permanent end use assemblies only certain more or less temporal configurations of materials whose value, function and worth may only be gauged relative to overall satisfaction of human functions and needs.

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TOOL EVOLUTION

Phase 3. Differentiation and evolution of machine tools--the integration of these tools into the industrial complex; review and analysis of generalized and specialized tools--automated processes and control systems--redesign and replanning of total world tool complexes and instrumentation systems, i.e., total buildings, jig assembled by computer within optimum environment control air delivered ready to use in one helilift. R.B. Fuller (1964)

The evolution of tools is closely interwoven with the evolution of man himself. Other animals have, in general, adapted to their environment by continual physical changes in the organism itself. Man has tended, from the moment he began to use tools, to free himself from any further physical evolution imposed by external environmental factors. He has externalized part of his evolutionary pattern into tools which 'do his evolving for him.... The human hand is the adaptation to end all adaptations: the emanicipated hand has emancipated man from any other organic evolution whatsoever'.[42]

Whether or not this viewpoint is wholly tenable, it does give certain insights into the overall evolution of tools--from the simple hand tool to the developed industrial tool-plant whose organic complexities and extensions parallel those of the human organism itself. We may observe also that through his tool development man has massively adapted the physical environment to serve his own evolutionary purpose. With the great tool system now available to him, he may even be able to exercise <u>conscious</u> control over his own forward evolution.

In this phase of the program, we are specifically concerned with the ways in which he has directly augmented his capacities, and increased his performance, by externalizing and amplifying his organic functions through technological means. One of the simplest examples of such augmentation would be the primitive hand tool which directly amplifies the hitting, grasping and leverage power of the human arm and hand. Such simple tools have developed into families of tool systems, which amplify many-fold the combined energies of large numbers of men, i.e. the automated factory is not only a series of augmented 'hands' but also an extra 'brain' or control system.

The augmentation of organic capacity is, however, not confined solely to the evolution of physical tools but includes also those 'invisible' tools which have had as powerful an effect in transforming man's condition. Such invisible tools as language, number, symbol and image systems are also extensions of human internal processes and have through the larger conceptual systems--religion, philosophy, science, etc.,--extended man's control over environment. We might even view the growth of social institutions as part of such psycho-physical extension--the development of cities, states, 'families' of nations. Certainly the development of the 'systems' capability of coordinating large scale, long-term complex enterprises, as in aerospace, long-range national and international planning, emerges as a powerful new technology. Also, where the hand tool, lathe, grinder, etc., extend physical capacities, our communication networks of radio, telephone, television and linked computer systems are extensions of the human senses and nervous system.

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42 "The Human Animal", LaBarre, Weston, University of Chicago, p89, 1954.

Through his instrumented monitoring of the electro-magnetic spectrum, man can now 'see' in the infrared, ultraviolet and X-ray frequencies, 'hear' in the radio frequencies, and more delicately 'feel' through electronic metering than with his most sensitive skin areas.

As man has extended his immediate physical control over the material environment, he has also extended his range of psychic mobility in space and time--to almost the same degree that he 'opens' up his future, he also extends himself into the past through refined archaelogical techniques and ancillary instrumentation.

The latest phases of technological development now return upon the organism itself as man begins to directly repair, restore and to replace his internal organs, either through transplantation from others or by artificial devices. His bio-technical tool services now range through plastic valves, tubes, filters, etc., to 'pacemakers' for the heart, external 'kidneys' and various prosthetic attachments which approach the natural limb capabilities.

Within the above review, we may discern two strands in overall tool development. One is the evolution of '<u>soft ware</u>' tools, such as language and other symbolic systems and processes, the other is the '<u>hardware</u>' tool development. Both are terms of descriptive convenience rather than actual type divisions, as they interweave dependently in the evolutionary pattern.

In distinguishing 'types' of tools, Fuller suggests that their essential developmental difference lies in their 'use' pattern. His analysis may be summarized as follows:

> "Apart from language, which one may term the first industrial tool as it involves a plurality of men, and is a prior requirement for the integrated effort of many men, early tools were local handcraft tools. They could be made and used by one man, or a few men, and could evolve from the limited set of experiences and materials of a geographically limited group of men, e.g., a dug-out canoe. The major industrialized tools, like an airline or telephone system, can only be made and operated by the coordinated effort of a great many men. They require drawing upon the material resources of the entire world for their creation, and they comprise within themselves the integrated experience, the science, which is drawn from the whole of man's universal experience. They are comprehensive systems, rather than local, and function most efficiently when organized in their largest universal patterns or networks."

Much of the extraordinary evolution of our complex industrial tools has taken place in the past 200 years. Though, by definition we might say that the first technological revolution comes, literally, with the invention of the wheel some 3,000 years ago,[43] our present period of accelerated development begins when the wheel is augmented by the steam engine towards the end of the 18th Century.

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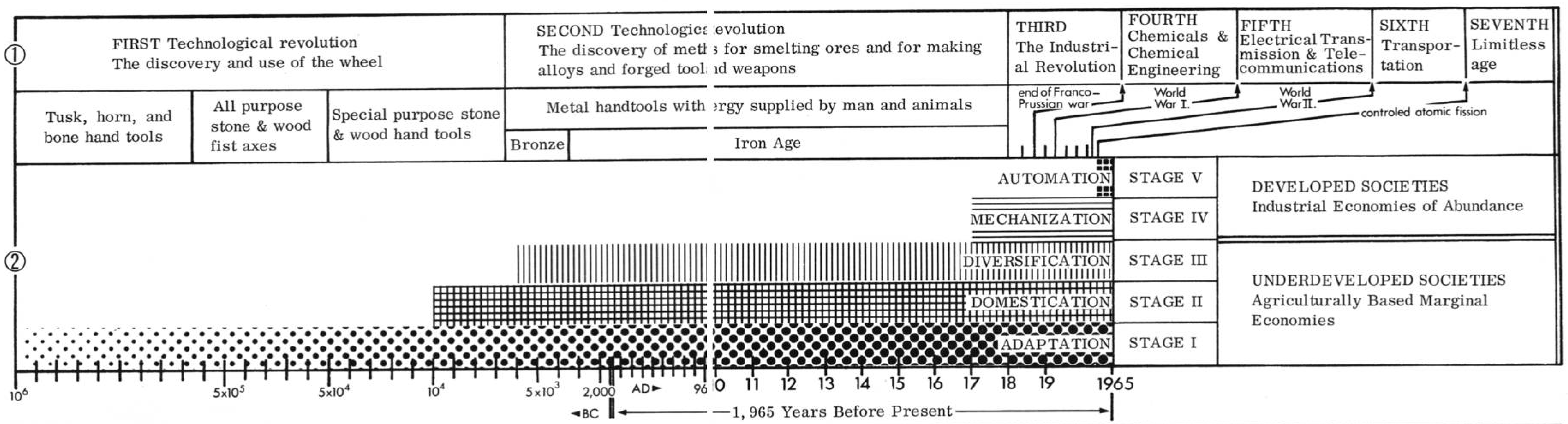
[43] Strictly speaking, this should be expanded to include the discovery of fire, boats, spear-throwers, bows and arrows, over 50,000 years ago; animal domestication and agriculture, over 10,000 years ago,etc.

STAGES OF TECHNOLOGY



THE LINE OF HIGH ADVANTAGE MOBILE ENVIRON CONTROL DEV OPMENT WHICH GOES FROM SHIP, TO AIRPLANE, TO ROCKET, TO MANNED SPACE VEHICLE													
MODE	Sailing Ships							Clippers	Steam Ships		Airplanes		Saturn V Rocket
TIME PERIOD	2,500 BC	500 BC	1,000 AD	1400	1500	1600	1700-	1800	1900	1940	1940	1950	1965
AVERAGE TONNAGE	150	250	30	300	100-500	1000	1,000	2,100	2,500	4,500	Propeller	Jet	3,000 Tons
HORSE POWER	80	120	30-90	150-250	....	500	750	....	1,200	1,400	3,500	12,000	200,000 lbs.thrust
AVERAGE SPEED	8 knots	8 knots	12 knots	10 knots	10 knots	11 knots	12 knots	17-22 knots	16 knots	20 knots	300 m.p.h.	600 m.p.h.	25,000 m.p.h.

(3)

DOMINANT AGES	MODERN CRAFT 1,000 - 1784	MACHINE AGE 178 1869	POWER AGE 1870 - 1952	ATOMIC AGE 1953 - 1965
POWER	Human and Animal Muscle Wind and Water	Multiple Horse T ns and Steam Engin	Gasoline Engines and Electric Motors	Atomic Energy and Fossil Fuel Burning Equipment Used to Produce Electric Power and Heat - Fuel Cells
TOOLS	Hand Wrought Iron and Wooden	Machine Wrought Iror d Steel	Multiple Machine Tools and Automatic Machines	Cybernated Factories with Computer Closed Feedback Control Loops
WORK SKILLS	All-Around Skilled Craftsmen and Unskilled Manual Workers	Subdivided Manufacturi Processes Replace Skilled Craftsn With Semiskilled Machine Op itors	Human Feeder or Tender Replaced by Skilled Inspector - Mechanic	Highly Trained Engineer - Designers and-Skilled Maintenance Technician Systems Specialist and Programmer
MATERIALS	Wood, Iron and Bronze	Steel and Copp	Alloyed Steels, Light Alloys, and Aluminum	Plastics and Super Alloys (32 New Metals Used, Notably Magnesium and Titanium)
TRANSPORTATION	Walking, Use of Animals by Dirt Road or Via Waterways by Sailboat	Horse and Buggy, Ste Trains Via Steel Rails, and S n Ships Via Ocean Ways	Automobile Via Paved Highways, Diesel Trains and Ships, and Airplane Via World Airways	Rocket and Jet Vertical Take Off Aircraft, Atomic Ships, Ground Effect Craft, Helicopters and Automobiles
COMMUNICATION	Word of Mouth, Drum, Smoke Signals, Messenger and Newspaper	Mail by Train and Ship, chanically Printed Newspaper, Tel aph, and Telephone	A.M. and F.M. Radio, Movies, Television, Magnetic Tape, Trans-ocean Telephone, and Microfilm	Video - Phone, Data Phone, Telstar & Syncom, World Wide Communication Satellites, 'Graphic' Computers

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This step towards a specifically industrial technology had its origin in the 'conceptual revolution' during the 1600's in Europe.[44] It is important to note that this earlier 'renaissance' was due, in no small part, to developments in maritime technology through which, around this time, man began to be newly aware of the extent of his globe. In considering the evolution of high performance tools, the ship comes early in the list, as giving a high energy conversion capacity not wholly dependent on human or animal muscle power. In considering the stages of technology as charted, we may preserve the emphasis on 'land' technologies but should keep in mind the parallel picture, which could be drawn, of the line of high advantage 'mobile tool' development which goes from ship to airplane to rocket to manned space vehicle.

The introduction of the 'modern' steam engine gives a convenient bench mark for the onset of the Industrial Revolution. As the period in which man takes off from a marginal survival type of society to one based on machine provided abundance, it is perhaps one of the most important turning points in human history. In a significant comparison to the social upheavals, i.e., the French Revolution, with which it is coincident, the first Industrial Revolution has been termed 'the gentler revolution'[45] --as accomplishing eventual prosperity and increased wellbeing for more men with less of the direct savagery and suffering engendered in the 'social' revolutions. It was evolutionary rather than revolutionary.

The tool, and advanced machine, developments which accompany the steam engine, and swiftly evolve into the large-scale industrial process, are too numerous to consider in detail here. We may concentrate, for our present purpose, on the machine tool and its concomitant developments of precision, controlled tolerances, technical standardization and resultant higher production performance. Machine tools are the key to the industrialization of mass production. They are the 'generalized' <u>tools to make tools</u> which are used to manufacture the prime movers and the mass production machinery itself. Machine tools are generally not mass produced as the number required does not warrant this. Mass production is carried out by the 'specialized' machines which produce standard items. These may be 'end' products, or components for assembly into larger mass produced items.

Through machine tools, industry really accomplishes self-lifting by its own boot straps. "On the lathe, man can make ten more lathes, instead of consumer products, and then ten men can go to work, each making ten more lathes, and each can be a better lathe than the one before. Thus, the whole world's overall tool capacity is swiftly regenerated towards comprehensive and plenteous capacity."[46]

The first basic machine tool is generally considered to be Wilkinson's 'Boring Mill' (1775) used to make accurate metal cylinders for Watt's improved steam engine. The lower performance of earlier engines of this class was due to poor tolerances in such cylinder making.[47] The boring mill was swiftly followed by the invention of the family of

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[44] Growth of the Scientific Method--the systematic derivation of scientific principles from observation and measurement of natural processes and their verification through experimental procedures.

[45] "The Nineteenth Century World")Part II, The Evolution of Technology by G.B.L. Wilson). ed., G.S. Metraux; F. Grouzet, for the International Commission for a History of the Scientific and Cultural Development of Man. UNESCO/Mentor Books, 1963.

[46] <u>Ideas and Integrities</u>, R. B. Fuller, New Jersey, Prentice-Hall, Inc., 1963.

[47] G.B.L.Wilson; Op Cit; Early cylinders for Newcomen/Watt's engines were <u>built up</u> and hand-shaped on wooden mandrels.

machine tool types which carry out basically the same operations today--drilling, turning, punching, reaming, milling, grinding and form cutting.

Of particular importance in machine tool development was the supporting concern with precise measurement and the use of standardized gauges, etc. In 1834, Whitworth raised accurate instrumented measurement (from Maudsley's one thousandth of an inch of 1805) to one millionth of an inch; his standardized screwthread of 1841, with constant angle of 55 degrees, was universally in use until 1948 when a new English-American standard was adopted.

Mass production industrial technology has similar early beginnings, generally located with Whitney's 'American System' of 1798, used for the manufacture of muskets with interchangeable parts, and with North's manufacture of 21,500 pistols by the same methods. Colt's revolver of 1835 used this system and his Connecticut armory contained 1,400 machine tools. One of the first large-scale uses of the copying lathe, in 1818, was in the turning of gunstocks by Blanchard (U.S.).[48] The mass production of clothing is also located around this period and associated with the U.S. Civil War uniform need. It is interesting to underline at this point the prior use of latest phase technologies as allocated to weaponry--a trend which continues to the present day.

The mass production of standard interchangeable components, then assembled through specialized division of labor into further complex units, remains in current practice. In the first phase of the Industrial Revolution, it spread and co-existed with the use of the machine to produce large amounts of 'materials', i.e., textiles, which then underwent further 'handcraft' processing.

The further development of mass production came with Henry Ford's use of the Whitney methods, in 1909, to manufacture automobiles. Ford's assembly line system first synthesized all the elements of the industrial process into a working whole; the division of labor, separation of work into specialized unit tasks; standardization of parts for interchangeability; precision tooling making standard parts of uniform 'fit' possible; the assembly line itself, the line-flow method of moving items, to be processed, past workers and machines at a steady timed rate. He also endeavored to create mass demand by fixing wage rates so that the worker/producer of autos could also furnish the mass consumption required to sustain the overall mass production process.[49]

Ford was also important in extending his assembly line method to encompass the supply of materials from widely separated remote centers in a timed sequence of transport and processing operations to their required point of availability in the 'home' production plant. Recognizing that the full development of industrialization implies global access to raw materials, he devised the 'mobile inventory' flow line of necessary raw materials which were ordered and purchased at their various extraction and processing centers around the earth and dispatched at precisely related intervals to converge again at their local U.S. processing centers -- thence to the end assembly plant. This 'organic' extension of the industrial complex coincided also with the availability of adequate railroads, steamships, etc., and, in turn, encouraged their growth as part of the overall evolution of major tools.

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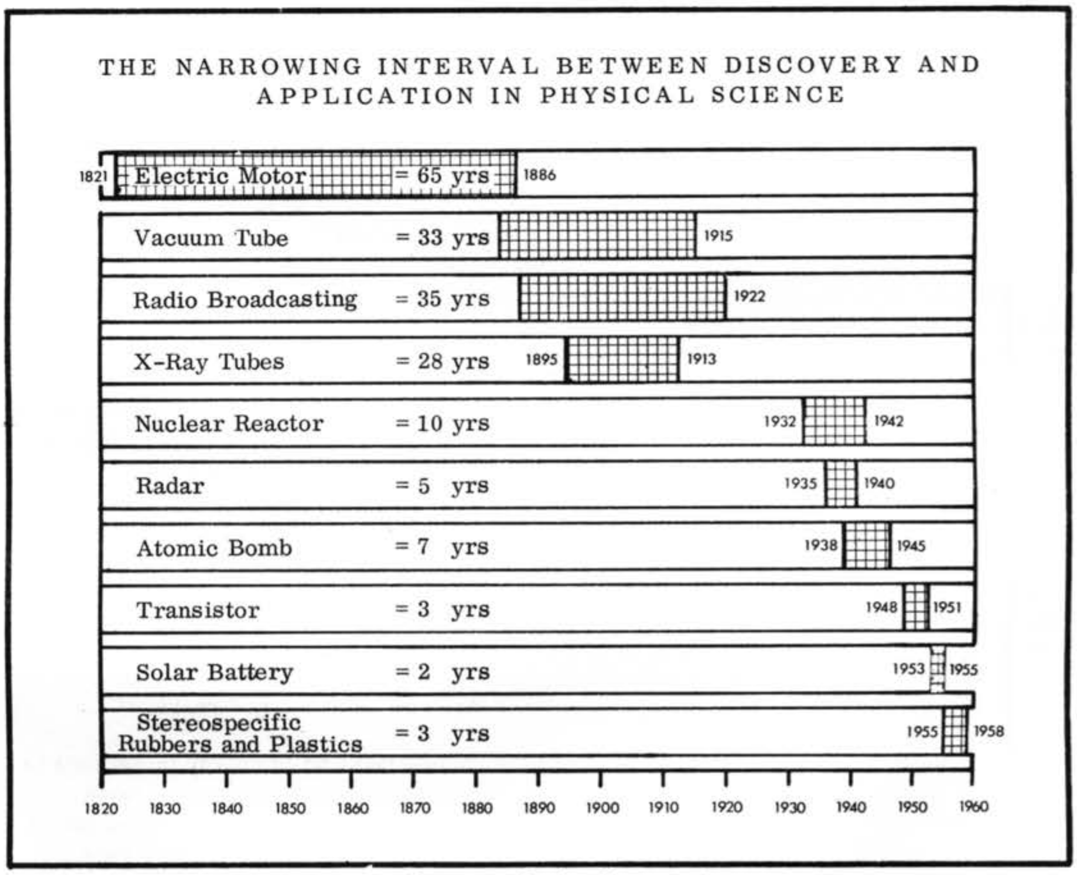
[48] 'The Wilkie Foundation', Doall Co., Ill., USA.

[49] 'Machines', Life Science Library, 1964.



Source: Technology and Social Change. Eli Ginzberg. Columbia University Press, 1964.

Though we have, in swiftly reviewing, by-passed the important aspects of the chemical engineering, electrical and electronic technological revolutions, we may note the accelerated, but seemingly orderly, expansion of the whole industrial process from this point on.

Ford's global mobile inventory flow system could not precede the railroad, which in turn required the steam and supporting machine tool development; the tools which improve the steam engine are preceded by the availability of metals and coal from the mines kept dry by the Newcomen engine, etc. All the various technological developments pace each other, and are paced in turn by scientific discoveries in the physical laws governing behaviors in energy exchange, metallurgy, alloying, fuel chemistries, etc.

This evolutionary process suggests an inherently 'organic' governing principle, or series of principles, which may describe the overall pattern. Fuller has described industrialization as such a " mathematical principle in universe"--and defined it as: "The objective, exact synergetic reintegration into a common, regenerative advantage of man, of all the subjective, exact differentiated energy behaviors discovered by all the individual explorations of all history's exact scientists." This 'reintegration' of scientific discovery into engineered application has progressively shortened as industrialization has developed its momentum--the steam engine took about 100 years to full application; electricity less than 50 years; the internal combustion engine under 30 years; the vacuum tube only 15 years--present developments in electronics, plastics, etc., are integrated within less than a year.[50] These decreases in time lags, or increased velocity of integration, are matched by corresponding velocity increases in other areas. In 1904, no man had gone faster than 110 mph. By 1964, man had reached 18,000 mph--an increase of 200 times. The computer can carry out calculations which would take a lifetime by hand--a factor of 10,000 increase in communication. By 1904, one man could reach 5,000 people; today, by satellite, he may talk to the world.

"Consider, for example, what is happening at present in certain fields, as typified, say, by the high energy accelerators of modern physics...In the late 1920's, atomic particles could be accelerated to roughly 500,000 electron-volts of energy. Successive inventions raised the limit to about 20 million volts in the 1930's; to 500 million by about 1950; and to 30 billion by the 1960's. Today one machine under construction is designed for 50 billion volts. This is an increase by a factor of 100,000 in energy--a factor of 10^5--in these 35 years, or a multiplication of the energy by another factor of 10 in every 7 years."[51]

When we come to consider increased performance per unit of energy investment in the industrial process, we will find again such corresponding exponential growth rates. These growth rates are evidence of the regenerative principle of technological development which improves with every re-employment. Experience and new knowledge feeds back into the process giving increasing degrees of precision and gains in performance.[52]

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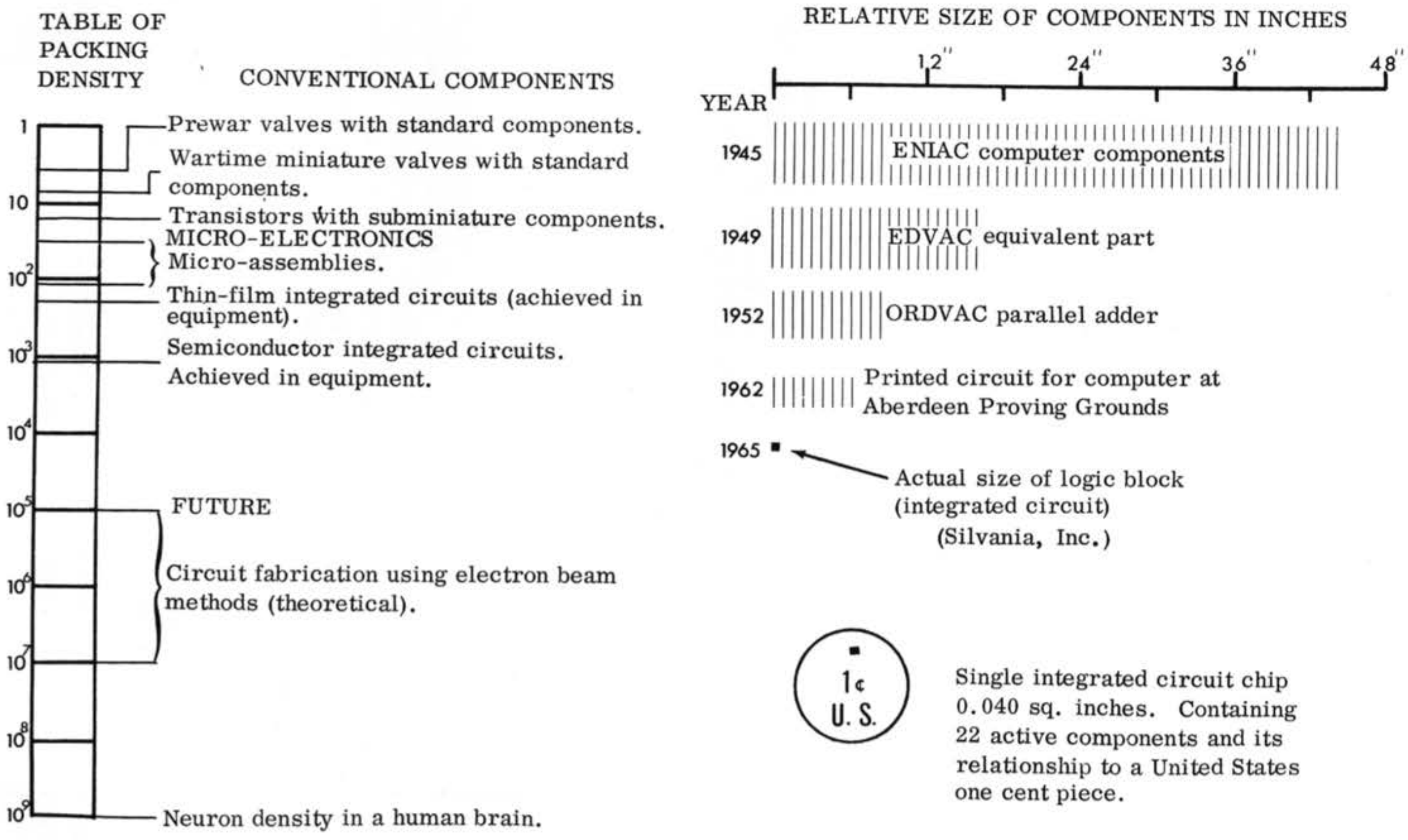
50 "Machines and Men", by Wassily Leontief, Science American, Vol. 187, Sept., 1952

51 'The Step to Man,' John R. Platt (Prof. Biophysics and Physics: Univ. of Chicago)

52 Large scale systems engineering as presently applied in aerospace programs now endeavors to encapsulate this 'rate of integration' development by anticipating forward requirements in materials, instrument development, etc.--by scheduling 'basic' research, technical refinement and other appropriately timed 'growth' developments within its long-range objective. This not only attempts to program discovery and integration but also to anticipate and incorporate 'invention' on schedule!

TREND TOWARDS MINIATURISATION
(MAXIMUM PERFORMANCE PER POUND OF UNIT RESOURCE)



Sources: (1) "Automation Surge", Science News Letter. (84:294) Nov 9, 1963.
(2) "The Exchange", Frank Leary. New York Stock Exchange. Jan. 1965.
(3) "Miniaturisation ad Infinitum". G.W.A. Dummer. New Scientist (432:500) Feb 25, 1965.

Each gain is also accomplished with less human and inanimate energy investment. In 1909, the year of the Model T Ford, the great shift to mass production by machine was immediately reflected in shorter manhours per output; by 1920, the U.S. overall manhour investment had leveled off and 'remained almost constant' until the early 1940's. Even at the peak (W.W.II), our total labor input with an enormously larger population was only ten per cent greater than in 1910.

Performance per pound is not only gauged in terms of actual performance delivered but also in reliability in performance. These two characteristics are particularly evident in the trend towards 'micro-miniaturization' in communication electronics and computors. With the order of magnitude of components reduced more than ten to twenty fold, this field is becoming known as 'molecular electronics'; circuits are reduced to tiny micro-elements which are 'solid state', with no soldered joints or loose wiring to invite 'failure' and decrease reliability. By integrating the functions of many transistors, and circuits into one block, they also give gains in 'warmup' and switching time efficiencies, etc. The 'Micropac' computer employs over 10,000 such units, weighs 90 pounds and occupies 2 1/2 cu.ft. A typical missile guidance system may weigh 60 per cent less than previous units and complete with computer power supply, etc., occupy less than 1 cu.ft. One new computer is actually 150 times smaller and 48 times lighter than the device it replaced! From its original weaponry use such circuitry has already gone into many other areas, particularly medical electronics, and promises, within a relatively short period, to provide a new range of 'evoluting contact products' whose scale will go towards invisibility. Recent micro-machining research at Stanford University, into components only one micron across, gives an estimated packing of several million components per cubic inch. Such micro-miniaturization began to approach the dimensional complexity and performance per unit of nature itself. Dr. Arthur Kornberg, Stanford Nobel Laureate, summed up the D.N.A. molecule, as the ultimate in miniaturization of information coding....(which) might be compared to the reduction of the entire Encyclopedia Britannica to the size of a pinhead'.[53]

Again, examples of this type could be listed for many pages. They are significant only, in underlining, for our purpose, the progressive de-materialization and ephemeralization which seems also to be an inherent trend in technological development.

All these accelerations in the integration of discoveries, reduction of input energies, increase in performance per pound, and their associated gains in productive volume and use capacity, are reflected in the current state of global industrialization. We have noted that the industrialization works most efficiently on a world scale. To maintain this efficiency through the successive feedback of increased reuse and regenerative cycles, it is obvious that the larger the number of people served, the more successful the equation. 'As men become dis-employed as physical workers at one part of the scale, others are swelling in the ranks of scientific and industrial research which develops the next wave of evolutionary industrial transformations.'[54]

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53 "DNA is Ultimate in Miniaturization"; D. Goldthorpe, National Institute of Health Record, Vol. XVII, No. 2, January, 1965.

54 Document One (1963) "Inventory of World Resources, Human Trends and Needs", p23; also contains charts of regenerative cycling.

The advanced nations of the West, however, are presently encountering some dislocation in their adjustment to the latest stage of industrialization--automation. Part of the difficulty lies in the hangover of obsolete installations, procedures and machine tools, due to their early industrial success and reliance on this as a seemingly 'static' security in various sectors of their economy. Noting particularly 'that two-thirds of the metal working machinery in the U.S. is ten or more years old,' Seymour Melman suggests that the machine tool industry must also consider mass production, both to refurbish existing inventories and to remain in the world market.[55] Another report (New Scientist, Mar. 1963) indicates that about 60 per cent of Britain's machine tools, and approximately 15 per cent of its steel-making capacities are similarly obsolete. The degree of relative modernization may also be examined relative to the rate of incorporation of computers in various countries.

The 'emerging' nations tend on the other hand to leap frog into the industrial era without retracing earlier Western development; they take off higher on the technological scale with a faster integration rate than the older areas. Though Japan is not strictly an example of an emerging nation, both she and China have made considerable industrial progress in the past decade. The latter's recent accession to nuclear energies is evidence of such capacity.

> "History may record the industrialization of Japan, Mainland Asia and India as the great economic event of the Twentieth Century just as the Industrial Revolution marked the Eighteenth Century and the great expansion of world commerce begun with earlier marked the Nineteenth... In effect these two revolutionary developments which spanned more than two centuries in their unfolding for the Western world, are now being brought in their full impact in...a few decades upon the three countries of Asia with 40 per cent of the world's people. The results must be far reaching."[56]

Integration of automation, as the latest phase of the industrial process, will undoubtedly hasten these developments. Defined as, "The mechanization of sensory thought and control processes".[57] Automation, though it involves principles already operative in the first industrial revolution, e.g., Watt's Governor as a self-regulating machine device, is essentially a new evolutionary stage in technology. As more directly the product of pure science, it embodies series of principles which have much wider applicability than previous industrial inventions like the steam engine or assembly line. It is not only that we may replace the sensory control of the worker in the assembly line by a more sensitive electro-mechanical device; but, also in that using the same principles on which such a device is based, we may replace progressively the various hierarchies of inventory control, production flow, organization and eventually major human executive decision over the whole plant, and plant-complex operations. The extraordinary range of new devices, processes, procedures and capabilities which the scientific discipline of cybernetics and its related fields have developed may not be more than touched upon here.

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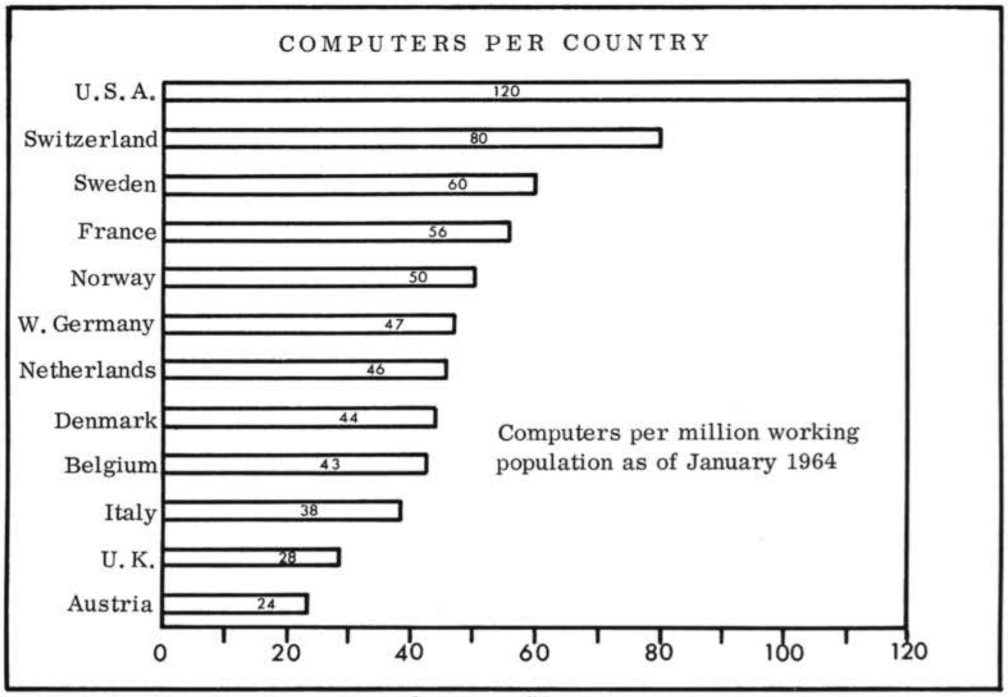
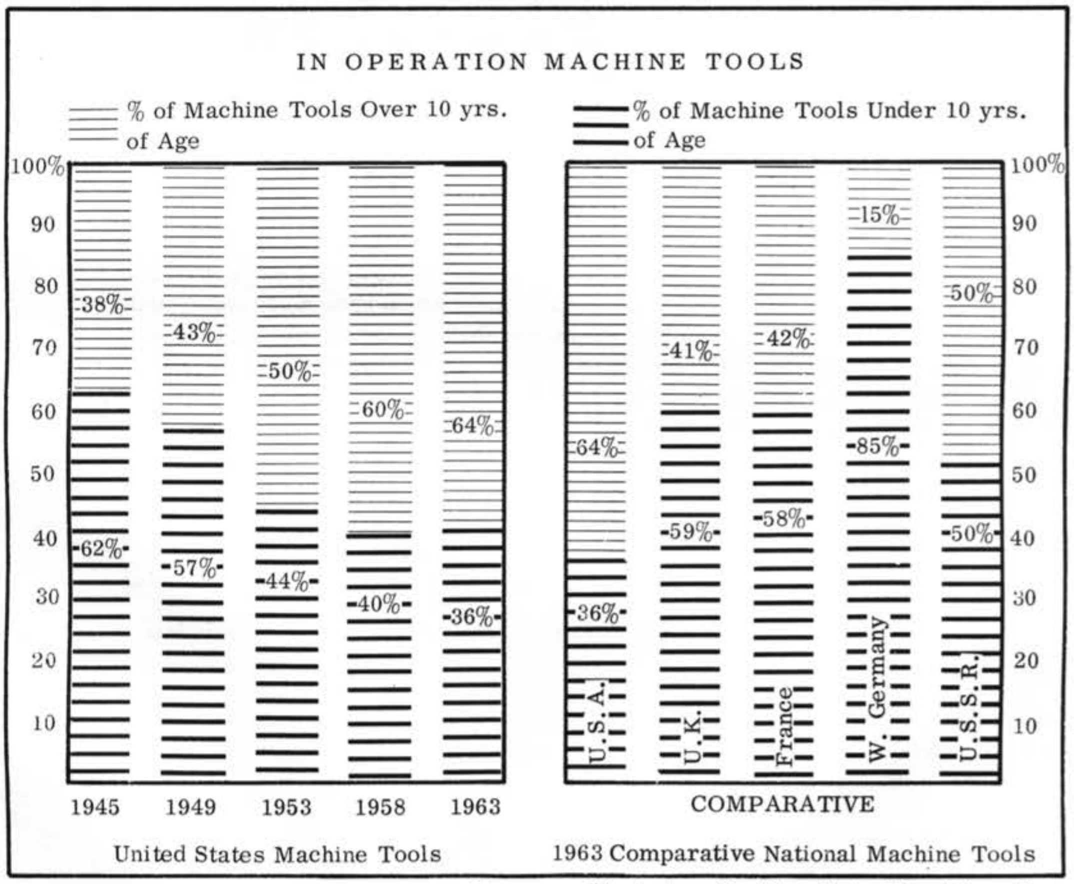
55 "Professional Industrial and Management Engineering, Columbia University, Author of 'The Peace Race'. 1961.

56 "Industrialization in Japan, China Mainland and India-Some World Implications"; John E. Orchard. Columbia University; Annals of Association of American Geographers, Vol. 50, No. 3, September, 1960.

57 "Jobs, Men and Machines"; ed. Charles Markham, 1964.



Source: "Computer Comeback". David Fishlock. New Scientist, England, Jan. 1964.



Source: "Industry-Tooling Up", Time Magazine. May 10, 1963.

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[55] "Professional Industrial and Management Engineering, Columbia University, Author of 'The Peace Race'. 1961.

[56] "Industrialization in Japan, China Mainland and India-Some World Implications"; John E. Orchard. Columbia University; Annals of Association of American Geographers, Vol. 50, No. 3, September, 1960.

[57] "Jobs, Men and Machines"; ed. Charles Markham, 1964.

Significantly arising out of weaponry needs in World War Two, the process of automation has many strands of development.

We may identify two main source areas as: One, that of electronics, and more specifically, radar and its attendant self-correcting anti-aircraft gun control devices which lead on through to the hardware development of the computer and many auxiliary technologies. From this area comes also the theory of 'feedback', which is the distinguishing feature of all that we are discussing here. Feedback may be defined, as the return to input of part of the output of an operation, or, as that information on performance which reports discrepancies between intended and actual operations so as to reinforce or modify the action of the operation, i.e., as self-correcting action. Two, the growth of operations research which arose from the application of the methodology of the physical sciences (e.g., logico-mathematical techniques, network theory, etc.) to the scheduling of military and logistics operations. This new software tool evolved swiftly into the post war 'systems' approach and its proliferated concepts of systems analysis, decision and gain theory, cost effectiveness, etc.

Automation is, at the level of industrial application, the fusion of these tools into a powerful new compound tool, rendering man obsolete as a 'mechanical' energy converter, industrial production worker or 'routine' worker. In the same manner the steam and internal combustion engines obsoleted the horse and draught animal as main muscle machine of the previous period. Within the machine process itself, it also introduces many revolutionary changes. The machine tool industry is now faced with a new range of technical advances in 'numerical control, modular design, electronic, high energy rate forming, electro-chemical milling and electro-discharge machining,' which tend to change the character of the tools themselves.[58] Various combinations of tool capacities are now possible. With the introduction of automatic controls we may now combine automated general purpose tools with high production specialized tools in a manner which enables us to mass produce not only standardized identical items, but at the same rate, to produce series of 'tailored' items with different conformations and qualities. Developments in 'throw away', expendable tooling, now in process, are likely to expand this capacity--which could give any required variety within a mass production run.

The above capacities, plus many other refined tools, are now available to the overall planning of comprehensively designed environment systems and for the 'tailored' production of very large-scale complex units.[59]

The designer may now deal with the 'design of the whole' once more. During the past period, in the design of large scale complex units, his function has been largely relegated to that of a coordinator of various specialists--structural, lighting, air conditioning and other engineers, etc. The special information of such specialists may now be incorporated in the memory storage unit of a computer and called upon as required. The direct design function which had also been reduced, in many cases, to the assembly of standard parts out of manufacturers catalogues, is now renewed, even in large scale 'mass' production, to the point where each item can be different and 'tailored' to specification through computer aids.

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58 "Science, Technology and Economic Growth", Clark E. Chastain, Impact: UNESCO, Vol. XIV, 1964.

59 One does not refer here to the present vogue in 'Industrialized systems building', etc., which tends to be the same 'prefabricated craft' unit mechanized and systematized to the extent that the 'boxes' or wall units may be erected more quickly.

New computer developments now go beyond recent numerical drafting systems, which simply mechanized an already routine process, to ways in which the designer may interact directly with the computor; having his design decisions and calculations checked and adjusted against its data storage with recall and print out at any stage. They are developing to the point where design may be accomplished through, and by, the computer, then phased directly into unit production by automatic tools through automated jig assembly to machine inventorying, checking, dispatch and transport to destination.

Chief among the design tools contributing to these man/computer/production capacities are 'on line' computer attachments such as Sketchpad, Rand Tablet, Calcomp and Grafacon, etc.[60]

The Sketchpad unit typifies the direction. Using this device whose communicating 'interface' with the machine or a T.V. type display tube, the designer may sketch directly 'on' the display tube surface with an 'electric eye' light pen which produces a glowing fluorescent line. According to the machine's instructions, such freehand lines are straightened up, circles are perfected, angles are made accurate. From the rough sketch, then, a precise figure is machine formed; it can then be altered, reduced, the whole or part enlarged (up to 2,000 times), and rotated so as to show other dimensional projections. For example, in designing a truss complex, the sketch may be drawn on the display face and various behavioral configurations under different loading conditions and different materials may be 'called up' and shown directly on the drawing. For linked machine units, parts may move in relative motion at various high or slow speeds and their parts stress behavior adjusted immediately and accurately through access to such data as is in the memory bank. All modifications of sketches, etc., are also stored. They, or any part of the displayed drawing, may be 'printed out' on command.

Rand Tablet operates in much the same way, with the refinement that the 'interface' tablet can also be programmed to recognize handwritten symbols, e.g., in drawing a rough auditorium sketch, instructions and equations may be included, etc. The machine output on the display face will provide the 'revised', acoustically correct, drawing, plus associated graphs and charts.

Grafacon and Calcomp are less complex devices, now in regular use, the first allows plans, graphs, etc., to be transmited into computer memory and 'displayed'; the second makes a reproducible drawing of anything that appears on the T.V. display oscilloscope surface.

All these various units depend for their most efficient use on massive memory storage, into which has been placed all the relevant information necessary for the anticipated operations, e.g., present capacities around 100 million bits--anticipated, about a trillion bits, comparable to a thousand sets of Encyclopedia Britannica. Such memories may include information on thousands of standard calculations, available on possible machine parts, operations, etc.[61]

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[60] Detailed review of such units may be found in Fortune Magazine, May, 1964, "Machines That Man Can Talk With", J. Pfeiffer.

[61] Interlinkage of such man/machine systems through various transcontinental centers is already established as forward development in computer services and will be more fuller discussed in Phase Four.

The above overall functions underlines the increasing obsolescense of man as a specialist, human 'information' source and the more urgent requirement for his role as comprehensive designer and overall 'systems' and 'pattern' creator.

The concomitant development of generalized and specific 'systems' analysis and formulation, which was earlier referred to as the 'software' evolving from World War Two's operations research, powerfully underlines this position also. Now officially referred to as a 'new social instrument' for large scale planning, it has enabled governments and industries to schedule huge long-range programs with many alternate strategies, and complexly interacting variable factors of research, development and manufacture, and to accomplish such schedules with timed precision over periods of years.

Defined as briefly as possible, systems procedures are concerned with the design of a set of operations or activities, so organized as to satisfy definable functional requirements, and containing within their design various 'feedback' sub-procedures which regulate the system towards the desired optimal 'end' function. The process involves:

1. The definition and statement of a given problem, function or series of functions.

2. Definition of the hierarchy of sub-functions or systems within this.

3. The constraints on the system as identified by end/sub-function criteria and associated variables.

4. The comparison of this 'generating' system with a 'model' system to select out the most efficient procedures.

5. Finally, the evaluation of the overall system design for optimal function.

At each stage, information gained feeds back into the design of the system.

In practice, 'systems' thinking has proliferated into a great variety of procedures using many different mathematical tools for analysis and similation, plus auxiliary techniques from communications theory, etc. Applications range from the relatively simple analysis of specific engineering functions, through the 'programming' of a missile system, to the analysis and simulation of regional and national working economies. They are now being particularly applied in the large-scale planning of those technical systems related to urban support-transportation communication and power supply, e.g., combination with automated methods, 'time required to introduce new designs of transport vehicles, power distribution schemes or construction systems can sometimes be reduced several fold. Plans for public works, which might otherwise take several years to achieve, may be expected in the future in weeks or months.'[62]

The engineering and automated production 'follow up' to such comprehensive design capabilities is already well advanced. Where Fuller referred, in 1964, to 'total buildings, jig assembled by computer...air delivered, ready for use in one helilift,'[63] this capacity is almost ready in use, for example, in aircraft and ship building.

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62 "Conference on Space, Science and Urban Life", March, 1963, p.108, NASA Publ. SP-37, U.S. Government Printing Office.

63 See heading to this Chapter.

Airfreighter building programs using light weight glass fiber 'self-jigging' assembly techniques, are producing large fuselage capacity units capable of carrying many tons. Such swiftly produced transport units, plus new helicopter lifting capacities, render the air-deliverable capacity of building of immediate practicality.

The actual computer 'jig assembled' total building is also presaged in presently developing naval war ship building programs. Such ships come closer to floating cities in their complexity than just buildings! In reports on recent work, it is pointed out that it normally takes 18 months to construct the hull of such ships, with three quarters of this time allocated to hull 'fairing' and full-scale loft drawing. Using computers this was cut to three days; complete structural designs could be completed in five days. Similar time/cost savings are indicated at each stage of such an overall operation, which requires approximately 5,000 separate job listings and more massive and complex inventories than are ever likely in buildings. A report, in Time Magazine of October, 1962, of a new Swedish shipyard describes this as:

> "The world's most fully automated shipyard, capable of building colossal 140,000 ton ships on the industry's first real assembly line. It throws out the old method of building ships on stationary ways from the keel up. Instead, ships will emerge from a giant assembly shed, stem first, in 45 ft. sections; as they move down the ways, everthing from deck plates to cabin carpets will be installed so that the ship does not have to spend months in a fitting dock after launching. As the bow of one is being completed, the stern of the next will start down the line. With a 40,000-ton tanker, the year will halve the normal 40-week period, between keel-laying and sea trials."

Within the 'warship' computer program described above, a comparison is given of the time/manhour costs for a comparable industrial steel building structure of eight stories, as normally requiring 50 design drawings and 300 shop detail drawings--taking 8,800 manhours and 61 weeks to complete. Using the specified computer program for construction, this was calculated to take only 1,700 manhours and could be completed in 5.5 weeks--with a minimum (critical path) program of three weeks.

The fully developed capacities to replan global 'tool' systems of fully advantaged environment controls for man are therefore to hand. It is required only that the emergent student comprehensive designer acquaint himself with the correct techniques and procedures to implement such full advantage for all men. As in swift review, we have traced tool evolution from the steam engine to the fully automated shipyard so he may trace out and familiarize himself with the evolution of the types of high advantage capacity that the task will require. This will necessitate, not only the necessary technical training in specific mathematical and engineering skills, but also the capacity to review and anticipate technological change and the manner in which it may affect social change. Man and the satisfaction of his evolutionary purpose remains the central objective.

MAJOR TECHNOLOGICAL CHANGES

	Character of Change	Technical Aspects	Possibilities arising	Effects on the Individual	Social aspects	Global aspects
1	Revolution in information: vast increases in computing and telecommunications capacity and wide use of electronic storage and retrieval of information.	Computers a good deal faster and easier to "converse" with. Computers linked in nation-wide and world networks. Messages by computer network (in digital code). Big increase in communications using millimetre radio, laser beams or communications satellites.	Television-telephones. "Dialling for news, books, etc. World-wide weather and disaster warning services using satellites.	Ready access to information (a data store in the home?). Close surveillance by government computers? Use of television links instead of business travel.	"Abolition" of libraries, paper-work and typists. Wide use of computers in every field of activity. Increase in local broadcasting. No more newspapers as we know them?	World-wide instantaneous reporting. Language translation. Big investment in communications (but increasing nationalism in these services?).
2	Revolutionary consequences of biology.	Understanding of living systems, including the human brain. Manipulation of genetic structure. Development of "bio-engineering". Understanding of ageing process.	"Biochemical machines" for food production, energy, transformation, chemical manufacture and information storage. Alteration of cell heredity. Engineering controls modelled on biological systems. Transplantation of organs and wise use of artificial limbs and organs. Modification of the developing brain. Conquest of viruses, heart disease and cancer?	Longer life. Better treatment of mental disease. Inhibition of ageing or "medicated survival"? Loss of individuality by surgical implantation?	Better understanding of human behaviour. Need for moral criteria in biological manipulations. Danger of a racket in transplantable organs. Danger of "mind control".	Understanding of complexity of living systems. Opportunities for enlarging food production.

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Phase 4. Analysis of world network of service industries, i.e., telephone, airways, communication services, hoteling, universities. General extension of dynamic network operating principles into formerly 'static' areas of environment control both internal and external. Frequency modulated--world planning of three shift, 24-hour use of facilities, i.e., most industrial facilities as yet operating under obsolete agricultural dawn to dusk, single frequency usage. Trans-sonic 1800 mph air travel transcends day-night and seasonal characteristics. Men literally jump out of night into day and out of winter into summer in minutes. Thus, local patterns of facilities employment trending swiftly into 24-hour succession of users, i.e., electrically lit telephone booths by roadside. (R.B. Fuller, 1964)

Service, as a craft industry concept, has a long history. Apart from the narrower area of personal services performed for 'masters' by servants or slaves, there were from the earliest times various types of 'inn' services maintained for couriers, merchants, pilgrims, etc. The monasteries, for example, in the medieval period were generalized 'embryo', service centers providing information, accommodation, health, guidance and other types of assistance for the traveller, or the local folk. The port service facilities set up for refitting, refueling, etc., by the early sea merchants have a direct line of development to the air terminal facilities of today. City growth may be viewed as that of a centralized service organism where specialized skills, facilities and other resources were maintained; the rise of the professions as 'service' occupations are also related to city development.[64]

The majority of men, however, as agriculturally based had little access to centralized services and were relatively self-sufficient in this regard. The home/family complex was the cooperative service unit. In such marginal economies 'services' tend to be restricted to limited personal service as most energy is reserved for production of essential requirements. It is only when man becomes more mobile due to environmental pressures, i.e., in migrations or large territorial expansions, or through the availability of energy surpluses, that we may note the growth of specialized services.

The first phases of industrialization stimulated much auxilary service for industry. Roads, rail and communication services spread rapidly around the world to help gain access to raw materials and redistribute these to the world market as finished goods. There was an accompanying growth in maintenance service for the more complex installations and equipment and for the greater mobility of men requiring hotel, information, personal and other services. The machine goods produced began also to require service support systems--spare part inventories, maintenance and repair services,etc.

[64] Our present major cities are essentially service interchange terminals in the world communications and transportation network.

The postal mail system, which became general also during this period, is an interesting case of relatively anonymous service system growth, which has quietly and invisibly developed into a reliable and indispensable world service institution whose activities are regulated through international agreement. We may consider also the growth of local and regional health services, and their present international role within the World Health Organization.

The railroad system, as one of the early major environment tools, took over, in the transport service tradition, responsibility for the provision of on route and terminal facilities--restaurants, sleeping cars, baggage service, inter-terminal communication, etc. You did not purchase a train or carriage in order to use the system, but a ticket for a specific 'serviced' journey.

Automobiles, though sold as an 'owned' product, required immediately for their full use the development of an extended 'service' network of roads, fueling stations, repair and spare parts depots, and their various auxilary enterprises--road signs and traffic regulation, auto service clubs, motels, restaurants, on up to today's developed 'drive in' services--from banks to movies to church services. Each of these auxiliary services has to be separately purchased; therefore, automobile usage is not strictly a service industry. The car as 'contact product' would be useless without its attendant support services. It is basically marketed as a 'service-in-supply' item with maintenance warranty, etc., as part of its initial cost.

The telephone, however, is a much 'purer' case of a service facility. The contact instrument is an identical 'anonymous' unit not 'owned' by the subscriber but remaining a rented instrument through which one 'taps in' to a vast invisible world service network. Behind the contact instrument, whose basic design alters little, there is the constant refinement and improved technological performance of the overall network service. From such services the subscriber has grown to expect the highest technological advantage to be swiftly available in the most remote locations. He also expects that the latest technical advances, i.e., satellite exchange services, videophone, will be initiated and incorporated into service through the overall facility.

There is also prominently developed as an evolving feature of such advanced services that they operate on twenty four hour schedules. To match up to the increasing ecological mobility of man, requiring whole earth twenty-four hour time availability of world services, such industries as telephone, airways, communication services, hoteling, typically provide day/night facilities. In effect, as globally oriented, they do not distinguish the former agriculturally oriented periods of <u>work/sleep</u> according to available daylight and seasonal hours. These become simply time increment divisions, traditionally and conveniently based on the earth's rotation around to the sun.

Relative to these various performance improvements, it is interesting to observe that no one would purchase an automobile whose technical performance, maintenance needs, and overall services, were so poor and little improved over the years as the average 'dwelling'. Comparing auto to telephone, who would now subscribe to a telephone system which was restricted to set routes; for which he had to pay for various performance 'extras'; which had no immediately maintenance of service on breakdown, and which could only reach a relatively small area of the earth?

In terms of 'tool evolution' it would seem that the more technologically advanced the industry the more likely that it is a service facility. All of our most advanced large-scale industrial enterprises are now service oriented rather than product manufacturing and marketing institutions. This trend has been further accelerated by the introduction of automated production. Products may now be manufactured in astronomical quantity runs, with less and less input of human and machine energies. The role of major public or private 'business' utilities is therefore not so directly concerned with the creation of 'wealth' through material products manufactured--but rather with the organization and regulation of the wealth distribution. There is then the shift in emphasis from production and product sales marketing to the wider concept of the service industry--whether this is in service of supplied products (auto) or service in the full rentable (telephone) facility sense.

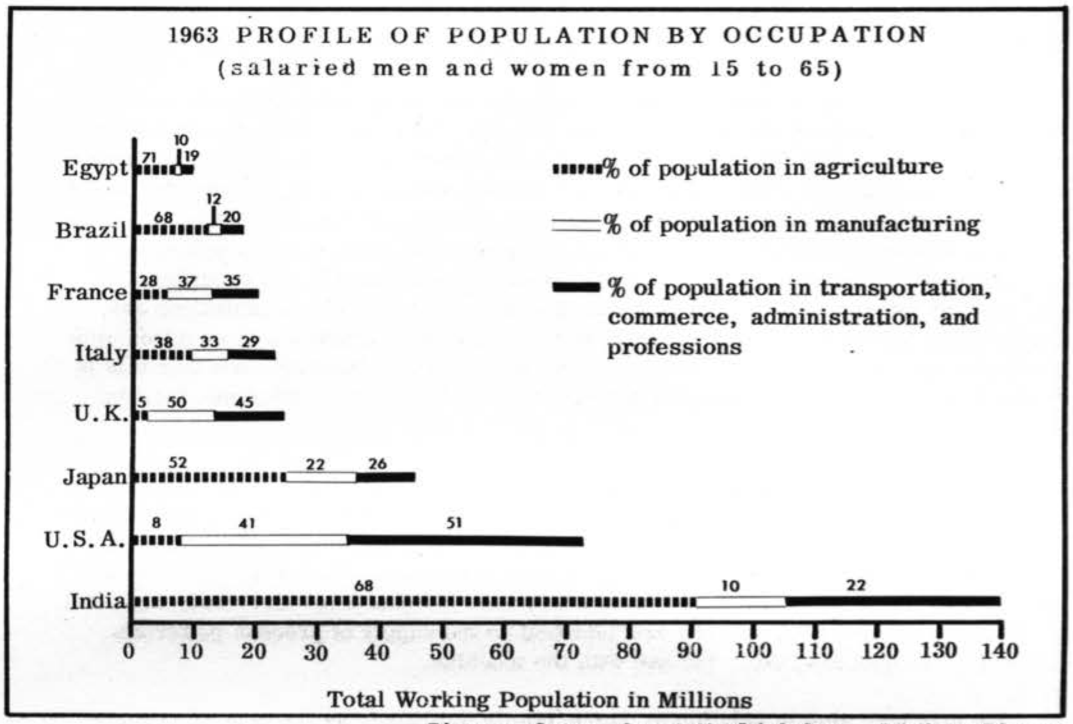
This is now occurring locally in various areas of new product introduction. The emphasis is placed not on the instrument or device manufactured but on materials supplied for use--or, on direct rental or linked rental operations. For example, information processing machines, i.e., copiers, duplicators, etc., for large-scale office use, are not purchased by the user but usually made available by the manufacturer on a minimal rental basis. The economics of the process are justified on the supply of process materials, papers, films, developers, etc., for use with the machine.

We may note also in relation to 'home/family dwelling', as the central service facility of earlier periods, that many of the previously home-based services are now externalized into commercial or municipal functions. Examples of these would be laundry, cleaning, refuse disposal, large-scale food preservation and preparation, water supply, heating, lighting utilities, etc.

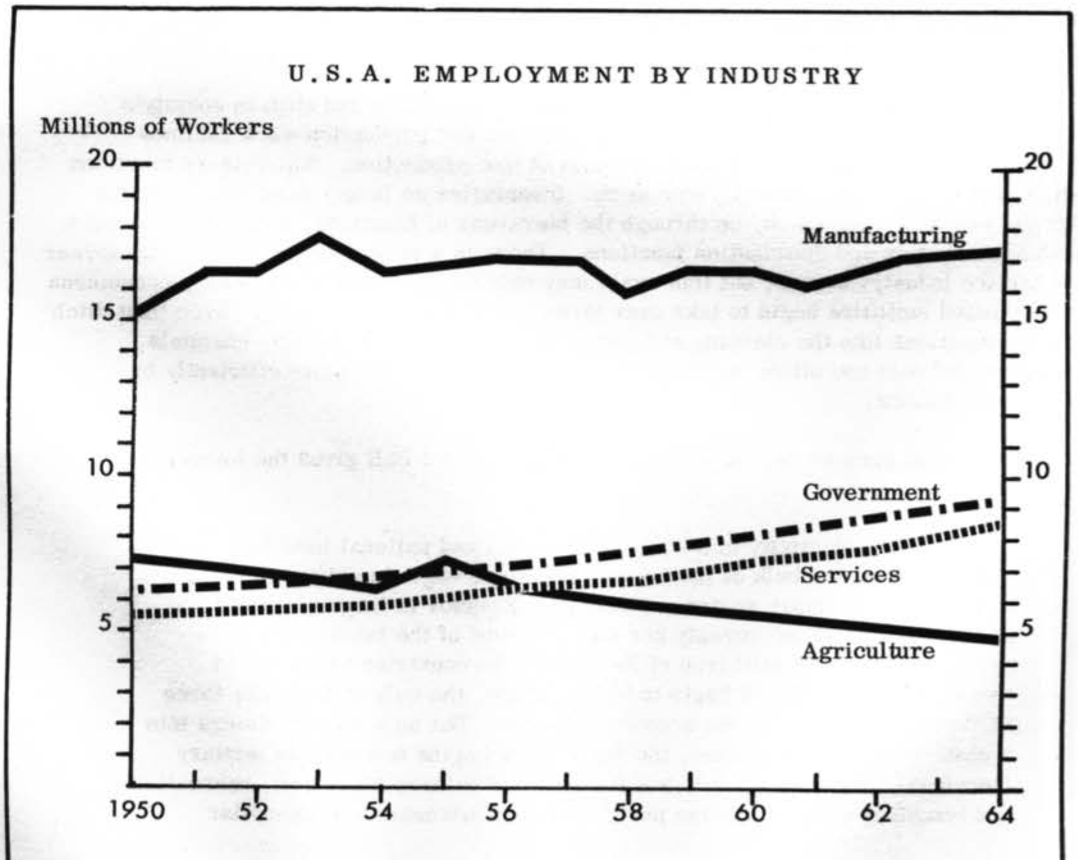
These developments are paced by changes in occupation and shift in society's orientation to work, production, leisure, etc. The manual production work declines obviously as more mechnaical energies are poured into production. Supervisory functions vanish as the machine regulates its own work. Inventories no longer need small armies of clerical workers--and so on, up through the hierarchy of functions, to include executive control of marketing and distribution functions. There is a corresponding shift of manpower to the service industry sector, but this again may only be viewed as a temporary phenomena when automated facilities begin to take over large areas of such servicing. Even 'last ditch' service occupations like the cleaning and janitorial maintenance of hotels, hospitals, restaurants, schools and office buildings are now being dealt with more efficiently by machine installations.

Analyzing such social and economic change, Daniel Bell gives the following summary:

> "...as the productivity in a society increased and national income began to rise, the bulk of the labor force would begin to shift out of what he called the primary sector. The primary sector is larger agricultural and mining, engaging seventy per cent or more of the labor force in unskilled work (a fact still true of the bulk of the countries in the world today). When countries begin to industrialize, the bulk of the labor force shifts into industry, or the secondary sector. But as a country enters into a phase of high consumption, the labor force begins to shift into tertiary (services), quaternary trade and finance) and quinary (research, recreation and teaching) sectors. In the past, thus, the increase in white-collar



Figures from: Great World Atlas. Readers Digest Inc. N.Y., 1963.



Source: Automation and Employment. Dupont Pamphlet, No. 27, 1964.

employments has come from the expansion of jobs in government, insurance, banks, schools and colleges, and the like."[65]

Bell also gives the following figures for the changing (U.S.) occupational balance indicating that the greatest growth of employed is that of the most highly educated workers:- 'in 1950, almost five million persons were engaged in professional and technical employment. By 1960, the number rose fifty percent to 7.5 million, and by 1970, the professional and technical groups will number ten million, or double the total of twenty years before.... By 197-, the number of white collar jobs will be twenty-five per cent greater than the blue collar ones.'

All of this points to the intensive expansion of the service industries concept. Not only to service in lieu of any machine capacity to carry out the task, or service in support of machine supplied items, but towards a vast ecological change in man's whole societal relation. The most phenomenal growth industry is in knowledge processing, both in the expanded capacities to amass, analyze and use information through the computer and in the primary sector of knowledge discovery, communication and development - education. Education is the key growth industry.

Let us glance first at the development of information processing and communications facilities.

Local information processing facilities are now available in many different service center forms. These include the 'drive in' type where the customer brings unprocessed data to the center, obtains free parking and use of an office and personnel to prepare the information, then uses any of a number of computer systems to perform necessary operations. Such centers are open round the clock, seven days a week.[66]

Local centers where processing is done on the spot are rapidly giving way to large interlinked data processing systems spread over a continent and with possible international hookups. Services already in operation, like Dataphone, facsimile wire services, Videx and Alpurcom, allow of remote information processing and communication at an unprecedented rate.

The Videx system transmits photos, charts and documents over ordinary telephone lines in ten to thirty seconds without any special cables.[67]

Alpurcom[68] is a high speed facsimile scanner and recorder capable of sending and reproducing graphic messages at up to sixteen times present network speeds. Using a nineteen inch wide standard or any width special recording head this can handle continuous flat copy at many different scanning and transmission speeds and including any media--voice, graphics, alpha-numeric data, machine language; all thinknesses from tissue to cardboard to magazine; all sizes from tape to full-scale drawings of an automobile or a missile; and in a wide range of colors, backgrounds and contrasts.

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65 "The Post-Industrial Society" by Daniel Bell; Liberty Mutual Anniv. Conf. June, 1962. (Referring to 'Conditions of Economic Progress', Colin Clark. Publ., 1940)

66 "Datamat" System; Statistical Tabulating Corp. (U.S.)

67 International Telephone and Telegraph Corp. (U.S.)

68 Alden Electronic Equipment, Co. (Though such information is approximately 12 mo. old, development is so fast in this area that such examples may be already obsolete.

Over the next decade it is anticipated that such facilities will be accessible through telephone, telegraph, etc., to millions of customers, and will have developed into new kinds of public service utilities. Through such systems, the executive could consult remotely stored records on tape or microfilm by merely dialing a code number.

The same system would give him access to work drawings, prints, photo copies, etc. Lawyers, for example, need no longer dig through hundreds of back cases but dial a law library for computer served answers to their specific query. Doctors may be able to dial diagnosis problems into a distant computer center to swiftly compare these with a vast number of similar cases.

Automation, in these terms, is no longer that of a single factory where discrete machines and operations are linked into a continuous flow but where such manufacture, inventory, distribution, etc., are continuously monitored and controlled throughout a continent.

In referring to 'systems' in planning development, we noted that this approach was being extended to whole regional and national economies. Academician V. Nemchinov (USSR) announced, in March, 1964, that his country had set itself the task of computerizing the operation of the entire economy.

"This is a matter of establishing a unified automated system of management of the national economy. It will comprise a net of computing dispatcher centers with a regular supply of information. The core of the system will be the main computing center with a system of electronic machines capable of performing three million operations per second."

He went on to say that the formula 'Soviet power, plus the electrification of all country' is now supplemented by, 'Plus the chemicalization of the entire national economy'- 'Plus electronics in control of the economy.' [69]

We may see, therefore, the continuing global spread and vast interlinkages of such computerized communications and control systems. What they also offer, of course, are enormous capacities for education; many have already been so adapted, e.g., 'Facsimile' blackboard telephones to accompany remote linkages of classrooms to a central educational service, etc.

The increase in education facilities is not only necessary to render such capacities available to all men but to give man increased social and individual control over such developments. Also, to bring to bear such marshalled intellectual resource on the future problems of societal adjustment to the accelerated rate of change itself introduced by technological development, and to investigate the possible evolutionary effects on man of, for example, this increased change and mobility. Man recently in satellite orbit went through a complete cycle of day and night, 'earth shine and earth shadow', every 80 minutes of his seventeen orbits around the earth. We know little about the internal metabolic 'clocks' which regulate and synchronize man's internal rhythms in relation to such abrupt acceleration of external cycles. As life becomes more interwoven with technology, it will be more vulnerable to the malfunction of large-scale systems and to the consequences of increased innovation, etc.

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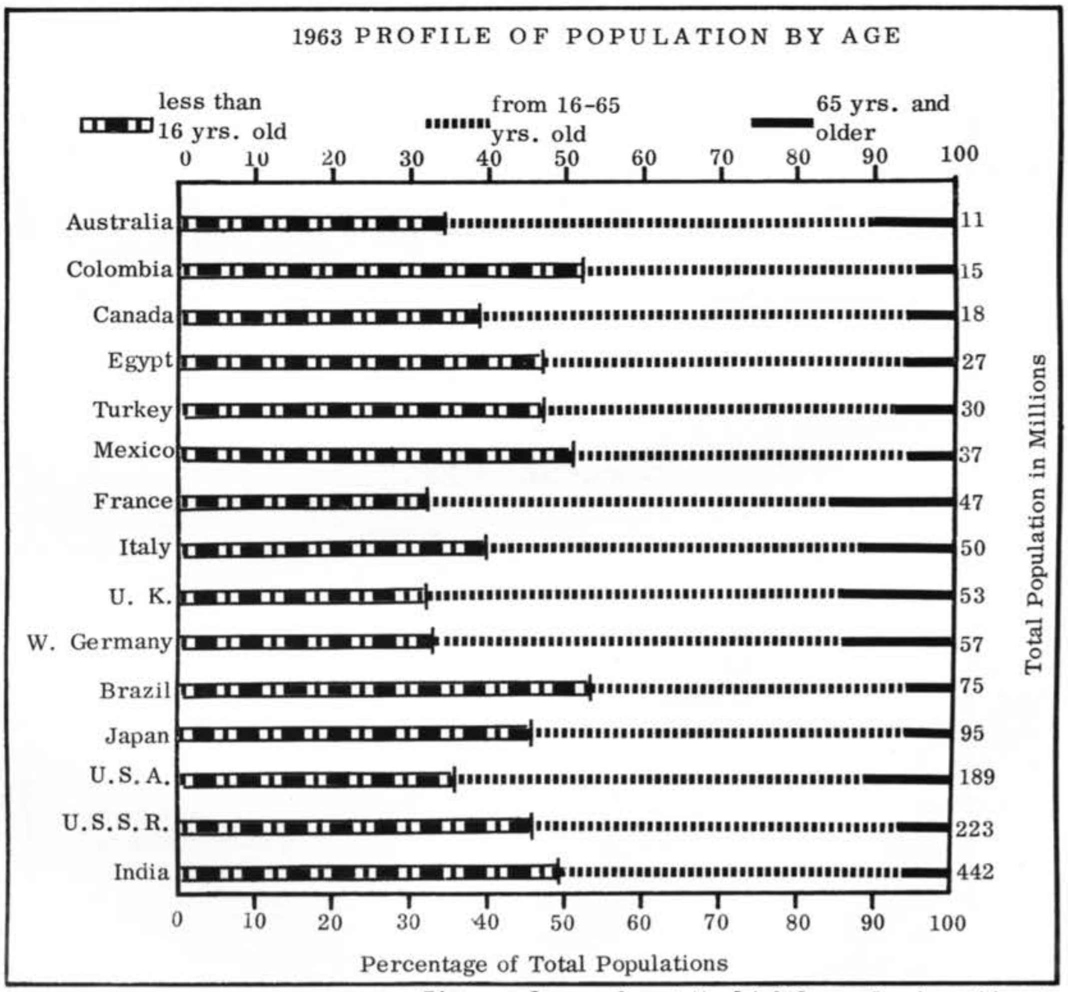
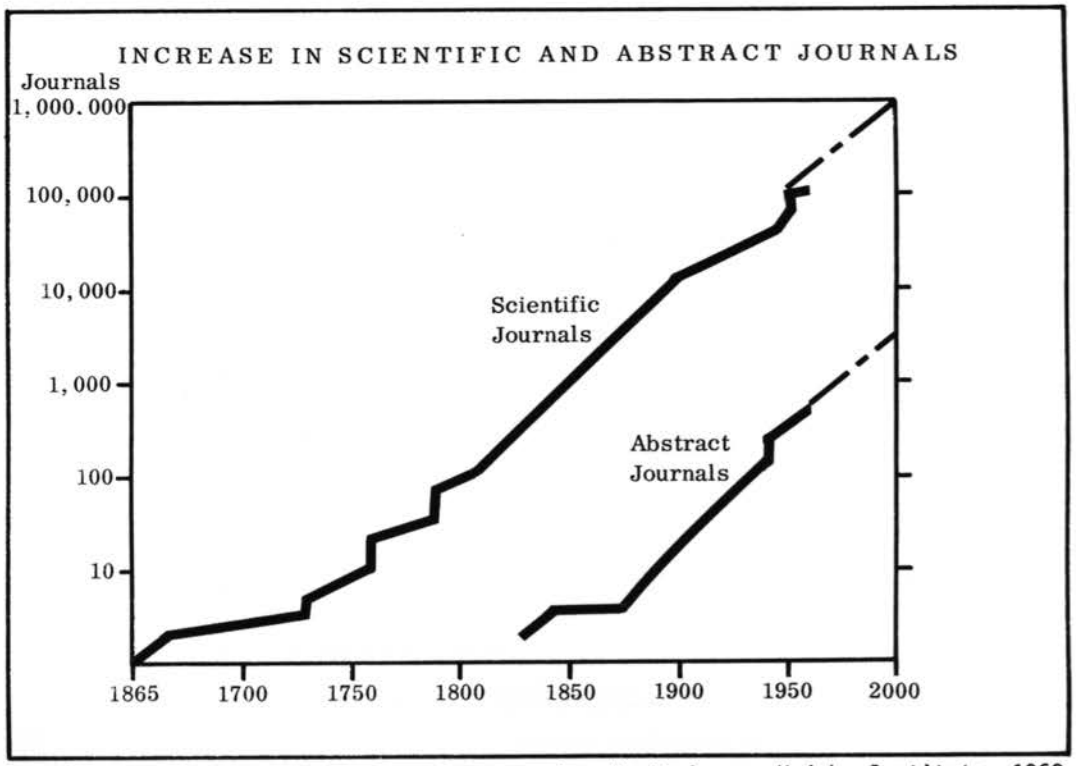
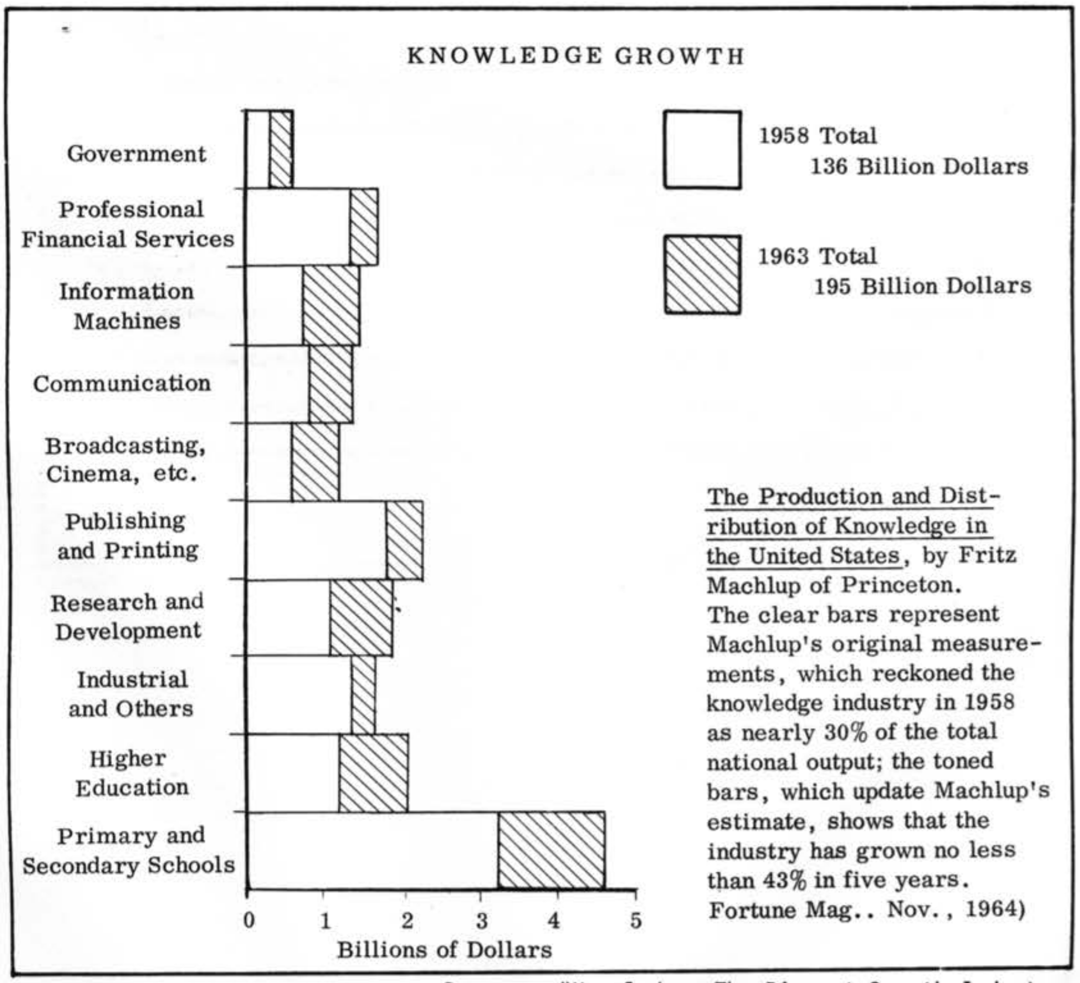
[69] Wassily Neimchinov, Soviet Economist, Mathematician. TASS service in English 1709 GMT; March 9, 1964.



Figures from: Great World Atlas. Readers Digest Inc. N.Y., 1963



Source: Dr. H. Striner. Upjohn Institute, 1963.



Source: "Knowledge: The Biggest Growth Industry of them All". Gilbert Burck. Fortune Magazine, Nov. 1964.

The whole question of education seems a focal point throughout our various phase discussions, and, as suggested within that phase, education itself may be considered from this point on as the key growth and service industry.

We have also touched upon the affects of automation on industry generally and the service industry orientation more specifically. Automation will mean more 'leisure' or re-investible time for large sections of the population. There will be generated, in turn, a need for:

(a) The retraining and re-education of those who may become displaced by automation, and
(b) The more extensive education of those preparing for life in our emergent society.

The term 'cradle to grave' schooling has been aptly employed to comment upon this all-embracing new education orientation.

As a service facility, education is already undergoing an extensive de-centralization. This is not only in terms of physical plant, i.e., the creation of more colleges, more training and re-training facilities, more associated research and development centers, etc., but also in de-materialized extension. Wired and wireless, piped and beamed facilities extend one teacher, one classroom or one college to possible vast peographical coverage--via telephone, television, air and satellite transmitters, computer linked libraries, and information services, etc. To extend the term used in the heading to this chapter--the dissemination of knowledge has become established on a true frequency modulation basis.

One may literally 'tune in' on knowledge through the radio, T.V. and telephone. With more sophisticated systems, now available, one may even individually select, and follow through complex sequences and instructional programs.

Advances in educational technology have now made available a number of measurably efficient self-instructional 'programmed' materials. These will swiftly develop into presequenced 'package learning' devices employing video tape, film, book texts, plus the remote computer linkages via libraries and control centers.

It is now literally and technically possible to have the equivalent of the school (or even college) actually in the home dwelling. This may very well be the indicated direction for educational and training development in the emerging countries. It is not really a new concept. The home/family dwelling for most people, in most of recorded history, was the prime educational environ, and remains so for almost all people in their earliest and most crucial years. But though the concept is not new the equipment and design foresight required to reconsider home/family dwelling as the prime educational environ and its re-integration as a fully advantaged unit are new.

A recent study[70] drawing attention to the crucial importance of the early years between birth and four suggests that:

> "Half of all the growth and intelligence takes place between birth and age four. The next 30 per cent increase in intelligence is made between the ages of four and eight. Between eight and seventeen, when the child is

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[70] "Stability and Change in Human Characteristics", Benjamin S. Bloom, publ: John Wiley, 1964.

of school age, intelligence increases only about 20 per cent. In short, just as much intelligence develops in the first four years of life as in the next thirteen and there is very little growth after eighteen years...

The conclusion must be that though it is tremendously important to provide infants with the most favorable environment during the first four years of their lives, the influence of the environment on intelligence becomes smaller and smaller with each year after the fourth and by school age is insignificant."[71]

Of course it is not only intelligence which is developed during these early years, but also the basic characteristics which determine much of the later behavior and personality of the individual.

If such findings are correct, our input of personnel, funds and energy into education should actually be reversed--we presently expend most effort on the years after eighteen and leave the birth to four years period to happenstance! A case could, therefore, be made for inverting the educational structure--that is to pay the mother, or other person responsible for the most important and formative years, more than the college professor--in due ratio to her greater responsibility!

Concerned, therefore, with the overall design of environmental controls for the optimal growth and development of man, we should underline the important role of the home/family dwelling as the area in which the prime development of man takes place.

In considering the forward design conception of world facilities for man's full developing ecological needs we would have then three areas of major concern:

1. Single family dwelling
2. Aggregates of family dwellings - communities, etc.
3. Educational service networks.

Considered as of advanced design and as incorporating the latest scientific and technological development, these are all service requirements.

Single Family Dwelling

In discussing this area we shall necessarily repeat some comments made in the first chapter regarding world housing. In noting, also in this chapter, that the other advance environment controls of man like the auto, the ship and airliner were part of comprehensive service systems, we underlined that behind their functioning there were full repair, replacement and maintenance systems. They also embody a high degree of anticipatory planning against part failure and have overhaul and performance improvement built into their efficient functioning. Specific industrial criteria which should operate in the design of dwelling facilities are:

"Minimum weight compatible with maximum performance,
Lower cost for maximum distribution and efficient production."

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[71] Quotation from review and commentary of "Stability and Change in Human Characteristics" by Benjamin S. Bloom. Review by Dr. Bruno Bettelheim, N.Y. Review.

The technical performance of such a living facility may not be realistically considered in terms of single isolated units, or as handcrafted multiples of such units but imply the full supporting technology of a developed industry of which house is the contact instrument. It would be as pointless to assume 'house' outside of this implied context as to discuss car, telephone or plane in the same terms--as isolated units without their support, service and forward development systems. The distribution of the human family is global, therefore, we should consider the facility as capable of performing adequately in every climatic condition found on earth.

The mechanical and structural aspects of dwelling have been dealt with in other works more fully than we could do here.[72] It may be useful, however, to state, or restate, certain aspects of 'house' services to ensure that they be given sufficient attention. The autonomous, or semi-autonomous function is an important one. Dependence on local systems of water/sewage and other utilities is one of the least efficient aspects of current dwelling. Apart from reasons related to depleted or polluted water supplies, there is also the trend towards deployed mobile living requirement in advanced countries, and, even more important, the fact that two thirds of the population in the developing countries live in rural areas. The trend toward urban congestion in the latter countries may be reversed through the provision of scientifically designed autonomously powered high standard living unit, which would embody the latest communications and other service facilities to accommodate rural deployed living.

It may be expected that the most revolutionary effect of man's success in aerospace will be the capacity to provide an autonomously operating and sustaining ecology for the human organism. The 'services' pack, resulting from such presently massive research, will provide man with a dwelling 'services' unit which will operate with equal facility in earth or the moon. If such service facilities require a transportation unit also, then this should form part of the overall design.

In considering the development of the lesser advanced countries, we noted that their industrial take off may be swifter than the already advanced areas. Automation and its attendant obsolescence of man as simply an agricultural or industrial producer may be anticipated as occurring swiftly in these countries also.

In designing dwelling, therefore, we should expand the home facilities in due ratio to increased 'leisure' or re-investible time. What were previously expressed as 'hobbies', entertainment, etc., become vital and recreative cultural pursuits. In exacting 'gainful' mechanical work, as required by pre-industrial society in return for sustenance and shelter, many of man's most important drives have been relegated to such marginal expression. The world living facilities service dwelling, to keep pace with the emergent global trending of man, will have to contain direct provision for the myriad ways in which he will wish to spend his increased daily, annual and life span. It may not be considered, therefore, as simply a shelter base where the wage earner's family live and where he or she (or both as is now more customary) return to in the intervals between work. It will, of necessity, have to be dealt with as one of the most vital core units in society and, therefore, fully advantaged with the most advanced technical provisions which may be envisaged as satisfying man's fullest needs.

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72 The pioneer exploration of R.B. Fuller in this area: See - (a) "Universal Requirements of a Dwelling Advantage" - Doc. Two (1964)-R.B. Fuller. Also (b) Ideas and Integrities by R.B. Fuller, N.Y, Prentice Hall, 1963.

A society also requires the direct and conscious participation of its members in its affairs, dictating that the home unit be equipped with the most refined means for such societal interaction and participation. The 'paper' franchise is no longer enough without the equivalent 'technological franchise' of access to full communications.

Apart from the changing character of 'work' and 'leisure', there is also the continued growth of the 'professional' in the work force. Teacher, executive, researcher, etc., are all terms which express complex and now multiple roles with correspondingly expanded and complex activities. There is presently no design provision made for these activities in relation to the home magnitude of these functions. Again we should anticipate the incorporation within the home of advanced communications, information storage and retrieval systems, compactly designed and remotely linked to necessary centralized control or depository facilities

But we have already extended the discussion of this section beyond present bounds for the reason that such aspects of dwelling are barely touched upon in conventional design scheduling. It should be noted that all of the advantages described above already exist. They are available design capacities, and are all, almost without exception, service units.

Community Facilities

As our main purpose in pursuing the design of environment control is to increase the 'degrees of freedom' which man may enjoy, we should also anticipate as many alternative ways of living as may be foreseeably required. We should therefore include among our proposed solutions not only the design of autonomous dwellings freely deployable for single family living, but also investigate the design of larger aggregate units as fully advantaged human ecology systems at the community size level.

We should not think of these as 'static' town plans, but as flexibly adjustable systems of community components--from school, college, hospital, auditorium, town hall, shopping malls, etc., down to multiple dwelling enclosures, individual and single family dwellings. Such community units may be initially designed to provide 'emergency' solution to world housing problems but in view of the rate of change in living patterns, and the rigidity of present communities relative to these, they may also be viewed as fulfilling a more general requirement. We should, therefore, investigate the generalized systems design for such an 'organic' aggregate living complex. It is obviously feasible to think in terms of flexible 'services' and structural components which could be assembled into the physical ecological controls for such a community.

We already have the technological capacity to produce such units in multiples and the systems experience in very large-scale undertakings to handle the complex variables of such an organization. The earlier example of the automated ship year demonstrates the production expertise which is available. For example, the large ocean liners presently in service carry three to four thousand persons, with all requisite high standard living facilities for long periods away from port. They are air-conditioned throughout. They have their own theaters, gymansia, swimming pools, shopping malls as well as full maintenance and repair facilities, and they furnish enough electric power to supply the requirements of communities of an even more substantial size.[73] For the highest performance per pound advantage, it would be preferable, however, to think in terms of aircraft plant manufacture at similar magnitude of unit complexity and assembly.

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73 Though not a passenger vessel, the first fully automated control 12,100 ton freighter was launched in Sept. 1964, with an electronic system which enabled one bridge officer to control all major engine and steering facilities.

Obviously such community components assemblies would be so designed as to meet all necessary 'local' physical and cultural conditions. One would aim at establishing such designs whose essential controls would be mass manufactured in the 'tailored sense and afford such assemblies as would allow for change and growth--through addition, subtraction or renewal of units no longer required.

In short, 'instant' cities! No below ground energy investment in wires, pipes, culverts; no above ground investment in huge concrete rock piles. No problems of urban renewal, congestion, dislocation or slum deterioration, as such 'cities' would be designed for required 'frequency' change and renewal from their beginnings.

Dynamics of Urbanism

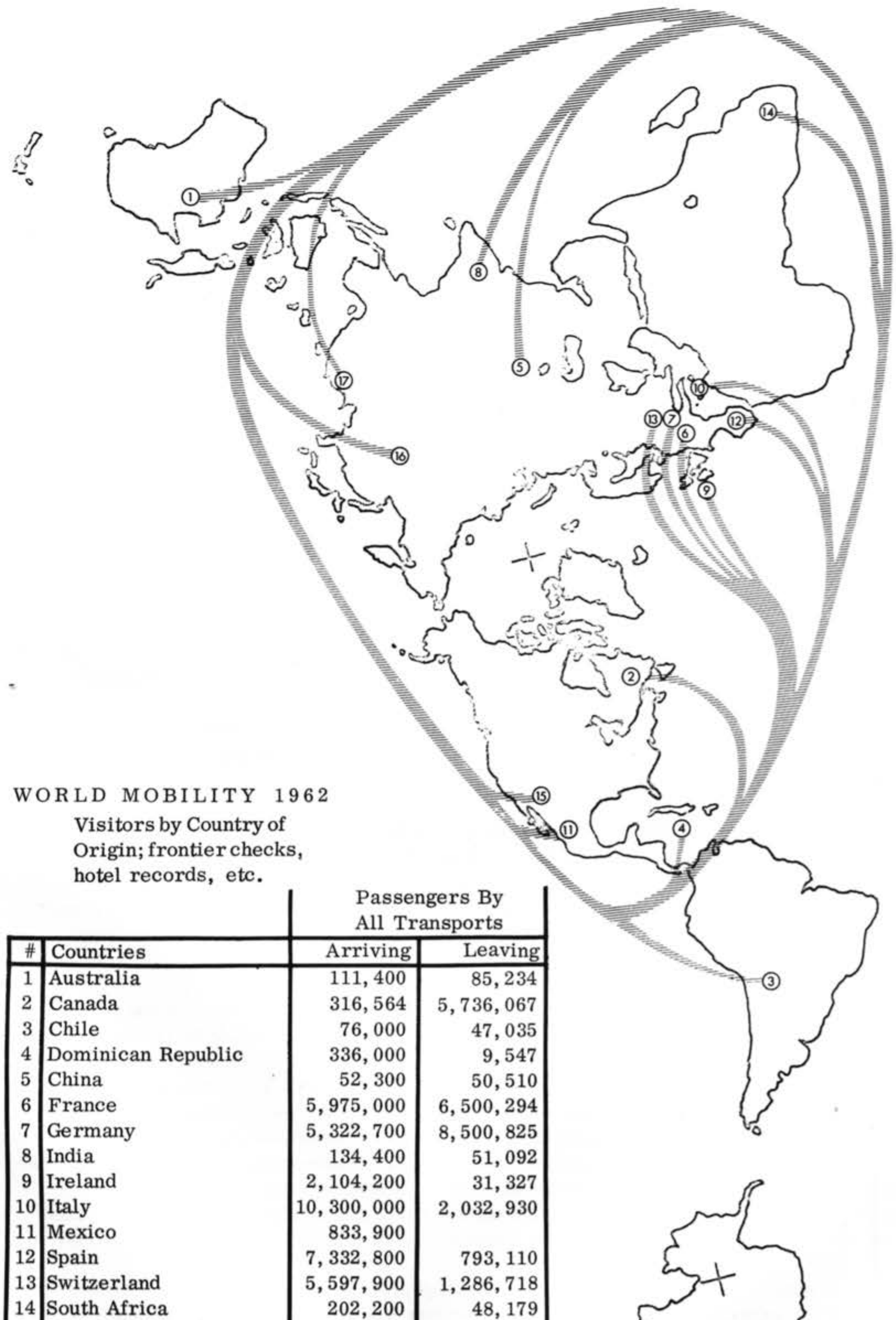
We have dealt in our discussion of single family dwelling and related community units, with the requirements of a new form of urban/rural living. This would also include the larger urban center - as a focus and interchange point for various services as well as being, in itself, a central 'services' complex.

Our concern has been with the increased mobility of man--both actual physical mobility and psychical mobility in relation to possible urban patterns. The emerging requirements of an extended new form of urbanism may be based on the rapidly developing autonomous services and transportation and communications networks. In approaching urbanism for this viewpoint, the city is but one type of waystation in an extended social and communication net. This view allows us to escape the dilemmas of much present urban planning, still largely based on the city as a static agglomeration of commercial/industrial production and distribution points related to railheads, docks, and warehousing facilities, and restores it as a dynamic node in an emerging society whose centers will be the great universities, the research and 're-investible time' facilities.

Urbanism is viewed then as but one of a number of possible strategies for deployed living. Advanced sections of society have already developed new ecological patterns in which living in town, or being in the city, is only part of an overall pattern of living which goes on in many widely separated locations. From review of the trends of man we may expect such flexible living patterns to become more prevalent as man is increasingly franchised around the world through industrialization.

Generally, in relation to urbanism, our thinking is still oriented to the city as center in an agricultural society or one in transition through the industrial revolution. We are now in the developing phases of successive 'industrial' revolutions -- in which refined electronic means have displaced most of previous time, energy, and space relationships which were the guide lines of our thinking. For example, the designed use of so many of our urban facilities is still tied to agricultural time, on a local dawn to dusk usage or other pre-electronic periodicity, no longer suitable to a world society which by its global nature functions around the clock. The city as the lodestone for 'earning a higher living' is no longer operative within the concept of automated, dispersed, industrial production plants whose location requires no labor pool concentrations as did the 19th Century industrial city.

It may seem difficult within transitional periods to avoid ad hoc solutions based on past workable experience, but present accelerations are so swift that such planning is often obsolete before it comes from the drawing board. In terms of lesser developed countries it seems particularly important that we avoid saddling them with such already outmoded planning concepts. Much of the literature stresses human 'settlement' but the measurable trending shows increased mobility and relative deployment and migration. Most often



WORLD MOBILITY 1962

Visitors by Country of Origin; frontier checks, hotel records, etc.

		Passengers By All Transports	
#	Countries	Arriving	Leaving
1	Australia	111,400	85,234
2	Canada	316,564	5,736,067
3	Chile	76,000	47,035
4	Dominican Republic	336,000	9,547
5	China	52,300	50,510
6	France	5,975,000	6,500,294
7	Germany	5,322,700	8,500,825
8	India	134,400	51,092
9	Ireland	2,104,200	31,327
10	Italy	10,300,000	2,032,930
11	Mexico	833,900	
12	Spain	7,332,800	793,110
13	Switzerland	5,597,900	1,286,718
14	South Africa	202,200	48,179
15	United States	1,060,700	4,382,424
16	USSR	909,600	163,377
17	Viet-Nam	39,700	

Source: 1963 Statistical Yearbook. United Nations, N.Y. 1964.

standard economic planning schedules note the transitional drift of rural populations in developing countries to already overcrowded urban facilities. They then plan to expand the latter facilities further, when priority might be more correctly assigned to accelerating the generalized communications networks and strengthening the locally dispersed autonomous centers. Similarly educational planning in such countries seeks presently to duplicate the static centralized learning centers of more technically advanced nations--when the state of education technology allows for the development of flexibly dispersed learning centers for various purposes interlinked to centralized library and other major facilities where required.

Urbanization in all its aspects is certainly an international trend, but, as noted above, we need to re-think clearly the precise forms of urbanism which are developing. Such congestion and over-crowding or urban centers as is apparent may be transitional only. The acceleration in individual and family unit mobility, and the developing patterns of 'professional' activities being conducted and coordinated at relatively distant working locations seems to suggest this. The growth of the university research communications center, with highly mobile populations, as primary focus replacing that of production/ distribution focal points seems also to underline a shift in concentration which may allow us to veiw the existing urban clogging as a problem whose solution lies in encouraging alternative growth patterns already underway.

Educational Service Networks

In dealing with dwelling service and the development of deployed remotely-linked services we have, perforce, discussed the emerging patterns of new forms of educational service networks.

It is only necessary to emphasize that where conventional planning begins with the static buildings or centralized enclosure for education, we are more interested in assessing the available 'high frequency' technologies which may enable us to deploy education so that it may be more widely available to all men.

For example, educational facilities for the developing countries are still thought of in traditional terms--of replicating the existing system of fixed hierarchies of schools, colleges, universities which obtain in the 'older' advanced countries.

We, rather, assume that with available capacities we can more swiftly, efficiently and economically take the education to the people--via mobile educational units, T.V., telephone and computer linked systems, etc. We should seek to define the kinds of networks, tool systems and home or community based 'contact instruments' we require. This may obviatethe need for, and delay in first constructing, the great static 'campus' units. They are also necessary, of course, as there is and will be a continuing requirement for various kinds of centralized complexes. But, by giving the buildings their present priority, the required expansion of educational facilities is enormously slowed down. Often, by the time such buildings are finally finished, they are obsolete monuments, ill-adapted to the process which they were designed to contain and serve.

World Service

The magnitude of such world service facilities development described above may seem too great for man's immediate implementation. It is in evidence, however, that our present global services, airlines, telephones, etc., have only begun to function at increasing degrees of efficiency as they were expanded to world networks. The 'natural' growth of such facilities is towards global service--the more people served the more economic the process.

TODAYS WEAPONRY POTENTIAL	vs.	TOMORROWS LIVINGRY POTENTIAL
4 attack submarines at $45,000,000 each	would pay for	1 year of agricultural aid for $178,699,760
One $105,000,000 atomic submarine minus missiles	would pay for	$132,095,000 in famine relief aid including freight costs
One $122,600,000 atomic submarine including missiles	would pay for	$150,000,000 in techical aid
One $275,000,000 aircraft carrier	would pay for	$251,000,000 for 12,000 high school dwellings
One $104,616,800 naval weapons plant	would pay for	35 school buildings at $4,000,000 each
One $104,616,800 naval weapons plant	would pay for	26 - 160 bed hospitals at $4,000,000 each
One $250,000,000 intercontinental ballistic missile base	would pay for	One 1,743,000 KWH capacity hydro electric dam
14 standard jet bombers at a cost of $8,000,000 each	would pay for	A school lunch program of $110,000,000 and serving 14 million children
One new prototype bomber fully equiped	would pay for	250,000 teacher salaries this year or 30 science faculties each with 1,000 students or 75 fully-equiped 100-bed hospitals... or 50,000 tractors... or 15,000 harvesters

Adapted from: (1) The Peace Race. Seymour Melman, 1961.
(2) Atlanta Journal, March 11, 1965.

We also maintain other, even more complex, world service networks, which may serve as comprehensive examples of such large-scale organization. They are, respectively, 'positive' and 'negative' -- one, the World Health Organization (WHO) devoted to livingry; two, the various world national and supra-national 'defense' establishments devoted to weaponry.

One function of WHO, which may demonstrate best its invisible and unobtrusive service, is in the control of possible world epidemics or plagues[74]--many of these scourges, such as smallpox which caused sixty million deaths in Europe in the 17th Century, have only recently come under relative control in many parts of the world.

Such 'plagues' are still a constant world wide threat whose monitoring and control required unremitting vigilance. With global air travel they might sweep around the world in a few hours. Under present international sanitary regulations, all countries must notify WHO headquarters in Geneva of the occurence of a case of smallpox within the day. From Geneva swift alerts are sent to all neighboring countries with connecting airline services. Shortwave radio announcements go to all continents and are monitored by all national health organizations, port health authorities, ships at sea and airlines already in transit.

In 1963 alone, about a quarter of a million smallpox cases were reported; in 1964, despite the precautions and regulations of the International Quarantine Service, smallpox travelled by aircraft from South East Asia to Sweden, from India to Poland and from Central Africa to Switzerland.[75] In all these cases, a world epidemic of possible astronomical proportion was prevented by the existence of the World Health Organization. This presents only one facet of its role as a highly developed world service facility on whose successful unobtrusive operation the entire world is dependent and which in turn depends on the fullest cooperation of all nations to maintain its advantage.

The other, and negative, example of a world 'service' networks is the 'defense' establishment of the world--in total. Based not on mutual cooperation, but mutual misunderstanding and distrust, these separate national and supra-national organizations impound a large fraction of the highest scientific and technical advantage in the service of destruction. Their present expenditures total is equivalent to almost nine per cent of the world's annual output of goods and services. This represents a large volume of human and material resources which could otherwise be used to increase world man's economic and social wellbeing. With support services, nearly 50 million people are presently preoccupied with the maintenance of these world networks of armed forces, bases, depots, communications services, research and development, production facilities, etc. We may include such an example, here, as it does represent the presently available capacity of man to design, construct and maintain what must be one of the largest, most complex, and technically efficient 'single purpose' facilities ever built.

There is much in the overall design of such systems which may be studied for more 'positive' purposes. In considering the comprehensive redesign and development of world service facility we need to examine all possibilities of turning even apparently negative aspects of world development to man's positive forward advantage. In the overall world ecological system there are no factors which are intrinsically negative or positive. Such bipolarity, even in nature, is interconvertible and represents only certain complimentary aspects of the whole process.

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74 UNESCO Courier. March, 1965.

75 Ibid.

Our larger purpose lies with the means of designing man's way forward so that world society may proceed to its next evolutionary phase. The great potential capacities of the fully automated industrial process, and the designed provision of a related and fully developed global system of high advantage environ control service facilities, would allow man to be freed from his age-old preoccupation with minimal survival. The possibility of an unprecedented abundance of material wealth renders obsolete the weaponry systems which are predicated on the pre-industrial marginal survival alternatives of 'your side or my side'. Now, even in world terms, there can be more than enough to go around--for the first time in human history.

In similar fashion, 'politics' trends towards obsolescence as the primary focus for decisions and solutions regarding material problems. Politics has been called 'the art of the possible.' This may have been appropriate in periods of material shortage with their various pressures and tensions resulting from unequal distribution of wealth. Today's art of the possible is that of designing appropriate systems for any desired possibility - or, the art of anticipating which of today's 'impossibles' are likely to be tomorrow's everday requirement.

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TOWARDS A WORLD UNIVERSITY (Appendix C)

International Cooperation

Cooperation between men, and between the nations of men, is the largely invisible side of the human enterprise. Each day brings fresh 'news' of conflicts and disagreements, whilst the phenomenal growth of human cooperation around the world goes almost unnoticed.

Man seems to cling desperately to the notion that he survives only by competing fiercely with other men. Yet, his biological continuity is basically a cooperative venture. His individual and social survival has only been possible through the evolution of various forms of cooperation. These have grown outwardly from the family, to the tribe, to the regional/national state and eventually to the present inter-national 'families' of nations. His survival strength has been based more on collaborative and unified effort than on fiercely competitive diversity.

This is nowhere more evident than in the growth of knowledge. Science, for example, is in essence a cooperative venture - men, working together, carry forward and build upon the discoveries of other men. Work on the frontiers of knowledge is now conducted on a world scale, through:

a) increased mobility and migration of scholars from one country to another,

b) international organizations, conferences, etc. and their journals and papers,

c) large scale cooperative ventures such as the International Geophysical Year, International Hydrological Decade.

1965 has been designated International Cooperation Year by the United Nations to mark their twentieth year of operation. During this period there will be a world wide effort to 'direct attention to the common interests of mankind and to accelerate the joint efforts being undertaken to serve them'. This international year is to be viewed not as an isolated effort for one year, but as a spring board for further concerted action.

Central to the objectives of the I. C. Y. is the idea that man's accumulated knowledge may be increasingly and more swiftly applied to the solution of his major world problems.

This aim of making knowledge more universally available, assimilable, and more directly applicable to man's living requirements has been the long term concern of many scholars. Comenius, the great 17th Century educator, was possibly the first to suggest that this might be best accomplished through a world organization of scholars[1] - who would meet regularly to assemble, discuss and find ways to use their collective knowledge for the benefit of all men.

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[1] 'Pansophiae Prodromus' (1630) by Comenius (Johann Amos Komensky, 1592-1630). Encyclopedia Brittanica

In effect, this would be a 'world university' - one whose central concern would be with knowledge treated in world terms, and so oriented as to be applied without regard to any restrictive local interest.

As a concept, it should not be confused with present 'centers for international studies' etc., already operable in various countries. These are often no more than 'cold war colleges', concerned with international politico-economic postures and strategies. Their internationalism is, generally, of the 19th century imperial variety and, therefore, of limited 'national'value in the world scene. In considering 'the world college', we need rather to emphasize the reality of a world which has been made 'one' - not by political or economic notions - but by scientific and technological fact.

In earlier discussion of the role of the university in our emerging society, we have suggested that they will increasingly fuse with the present urban/communications centers, or develop on their own, to become the major nerve centers of society.

As institutions they have an extraordinarily viable potential for influencing and guiding decision making, and providing leadership in society.

> The ecology of universities is remarkable: they reach back to the middle ages and they girdle the Earth. From the plains of Lombardy they have been transplanted to the grey climates of northern Europe, to the African bush, to American cities. They have invaded the ancient civilizations of Egypt and India and driven out institutions deeply rooted in the indigenous culture. They have adapted themselves to totalitarian and to democratic societies, to rural communities and to urban technologies. But through time and space they have preserved something resembling a genetic identity: they remain unique as instruments for investment in man.[1]

This 'ecology' is now global and the local university may be considered as already functioning as part of a large network extending around the earth. Within this net, ideas, discoveries and new configurations of knowledge are constantly in flow. It may be viewed as a kind of extension of the individual intellectual consciousness into a global 'consciousness'. One contemporary thinker[2] has termed this 'natural confluence of grains of thought' as the noosphere' - a concept somewhat similar to the biosphere[3] within which the living organisms of the earth, air and sea are sustained. The noosphere would therefore be the sustaining envelope of human thought around the globe within which knowledge is circulated, recreated and transformed.

The World University

There have been a number of recent proposals which recognize this new ecological phenomenon and seek to give it more concrete direction through the formal inauguration of a world university.

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[1]'Investment in Man' by Sir Eric Ashby, FRS, New Scientist (No. 354) August 29, 1963.
[2]"The Phenomenon of Man" by Teilhard de Chardin, The Cloister Library, Harper 1961.
[3]See 'The Big Alphabets' Appendix.

The most realistic of these has been advanced by the World Academy of Art and Science. The introduction to their 'Plan for a Transnational World University' is given below:

> 'Many detailed projects have been worked out for the establishment of a World University, but all of them remain confined to the idea of an actual, physical center, a kind of international but locally determined campus, where people from many countries and races could meet and study.
>
> We do not think that such an Institute would apply under the present political conditions to the concept of a World University, or would apply to it in the foreseeable future.
>
> On the other hand, a close scientific cooperation, not bound by geographical limitations of any kind would factually lead to it. In this way, it will be possible to enlarge the traditional concepts of academic work and to combine efforts undertaken in different places of our globe into worldwide research on problems affecting humanity as a whole.'

The steps towards the realization of this goal envisage, initially, that a number of our present universities will be willing to act as 'world centers'. They would then engage in collaborative research on specific world problems with other centers. As this team organization grows more closely knit, related teaching activities would also be engaged upon - with preparation of suitable text books, course work, etc., leading to appropriate degrees and titles of general validity. The final step would be, 'When the teams (are) sufficiently integrated, the cooperating universities or a great number of them will declare themselves part of the "World University", but not before about 50-100 of them on at least four continents are actively cooperating. This is not to be envisaged in 5-10 years.'

This program is eminently feasible. It recognizes fully our present capacity for engaging in widely deployed and decentralized world activities, within which individual co-workers may still be in close 'electronic' contact - daily, hourly or even minute by minute.

In discussing of the role of such team research, one of the distinguished members of the W.A.A.S. has formulated this in a manner which comes close to defining our "World Design Science Decade" activity, as:

> 'Providing suitable university and industrial cooperative arrangements make it possible for adequate numbers of able young men to learn the advantages of competitive cooperation through participation in team-research within both science and industry, and particularly through participation in such tectonic team-studies as can cause the world's available supplies of essential minerals to continue to expand from year to year, despite the ravages of depletion, and despite a continuing rise in the world's total requirements - both for essential mineral raw materials and for mineral sources of energy.'[1]

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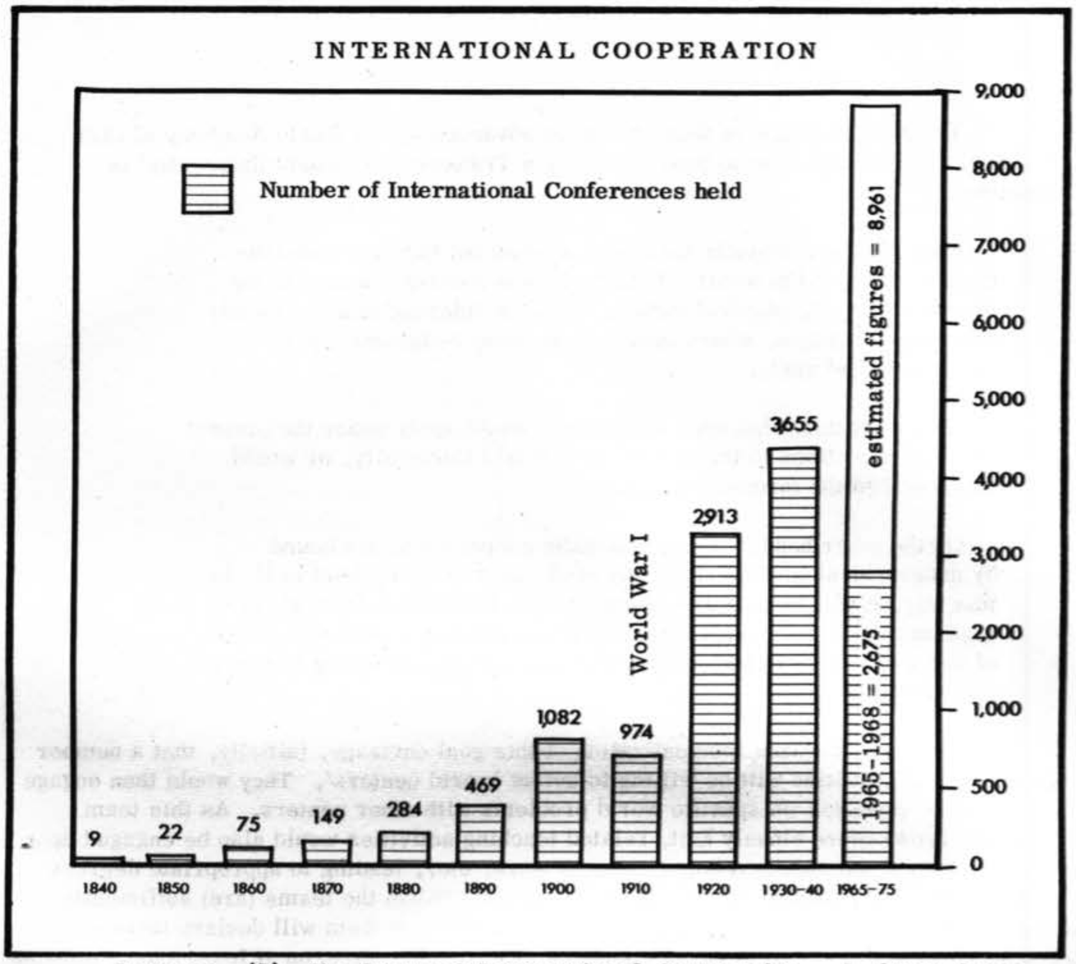
[1] 'Tectonic Team-Research, Key to Social Progress and World Peace' by W. T. Thom, Jr. Paper given before New York Academy of Sciences January 7, 1952.



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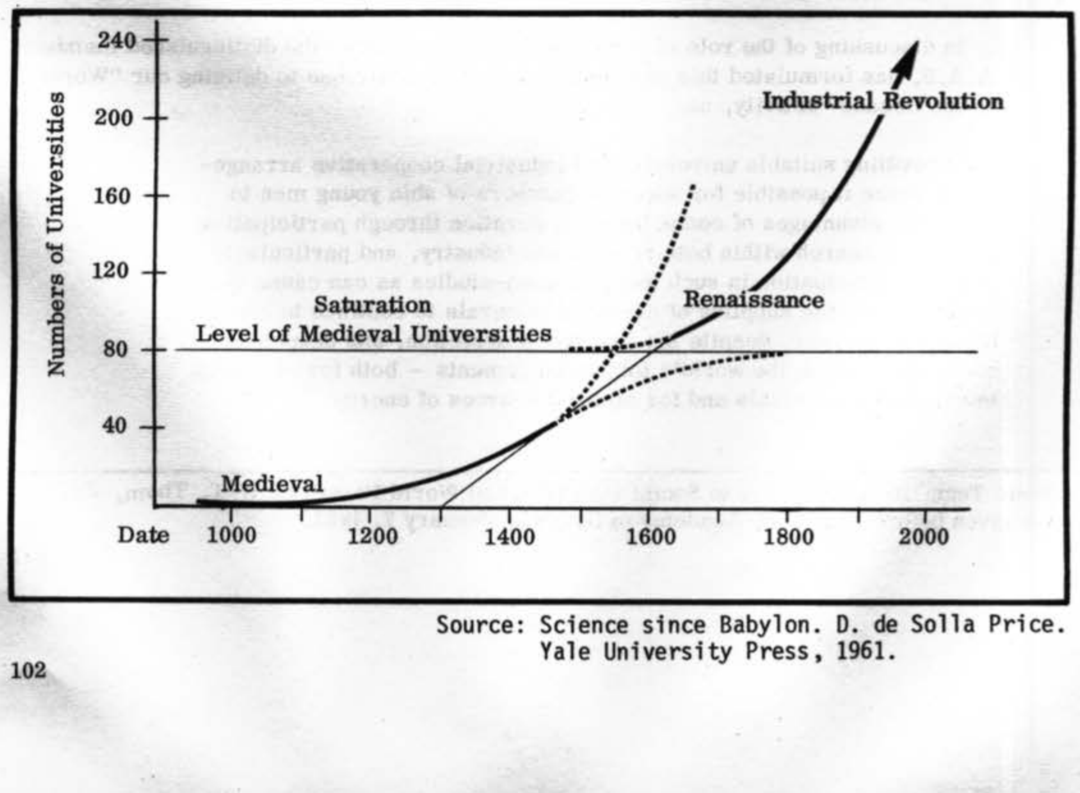

Source: Science since Babylon. D. de Solla Price. Yale University Press, 1961.

An experimental prototype for a world college has already been tried out, during 1964, in a project sponsored by the Quaker Society of Friends. Twenty-four U.N. countries including the U.S.S.R. and U.S.A. were invited to send their student recommendations. From 300 applicants, 24 were selected to attend the first sessions. In commenting upon this experiment, one of its leading founder members states that:

> 'It suggests a college unlike any now in existence, to which would come students from everywhere in the world, Communist and non-Communist, Western and Eastern, Jew and Arab, Christian and Moslem, colored and white, each of them different, each of them welcomed and cherished because of the difference.
>
> There the students would be taught, by scholars from across the world, a body of knowledge that would contain, not nationalist histories and ideologies, but the history and culture of man in the entire world.'[1]

As a result of the success of this venture, it is hoped that similar centers may now be set up in various countries. Part of the development of the college includes the possibility of moving part of the student body each six months to a different center of study in another part of the world.

Associated with these world developments are various others which are of comporable and related interest for the 'World Design Science Decade' program.

An International Scientific City

This project has been briefly referred to in the first chapters of this text. Its key aspect would be the establishment of an extra-territorial 'scientific city' devoted to the particular study, and provision of solutions, to specific world problems. The initial problem chosen for this first center is world literacy.

A site has already been offered in Italy and the Italian government appears favorably to the granting of extra territorial rights for this purpose.

The city itself will be organized as a large scale research, development and mass production facility for a complete range of educational systems. These will be specifically designed to assist the developing nations to swiftly raise the literacy level of their populations and to improve their overall educational system. It will be a 'jointly-owned common undertaking, flying neutral colors, based on extra-territorial ground and supported by the most highly developed specialists around the world.'

In reviewing the reasons for setting up such a city, its founders point out that though many groups of scientists and organizations already exist for the study of world problems, their practical solutions are hindered by various factors. For example,

a) the absence of a global program of information exchange,

b) the lack of a world coordinating body,

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[1] The Idea of a World College by Harold Taylor, Saturday Review November 14, 1964.

c) that existing international agencies for such purposes all too often get bogged down through their inter-government relations,

d) such agencies can rarely avoid political bias in their discussions and actions.

Their development plan, for utilizing the most up to date audio-visual, electronic automated systems in combating illiteracy calls for 'the largest possible cooperation of the numbers of countries concerned, an industrial production related to the size of the undertaking' and the highest scientific and technical competence in its execution. They underline also the necessity for the most rapid implementation of the plan so as not to be overtaken by population increase and its attendant pressures etc.

The practical recognition within this project that the study of the world problems is not enough, nor their local and piecemeal solution, is parallel to our own program. We also state that present world problems are only amenable to those solutions which emerge from the application of the highest scientific and technological knowledge and which may be implemented in terms of the most advanced industrial production available.

An International Territory of Science. (Antarctica)

It may be a fitting conclusion to this section to include the following extract from a recent report on the development of the polar regions under terms of international agreement.

"Since 1955 a number of international scientific bodies have been set up to organize the systematic study of the Antarctic continent. First within the framework of the Special Committee for the International Geophysical Year and now within that of the Scientific Committee on Antarctic Research (SCAR), the programmes and their co-ordinated execution have been studied by the representatives of the countries participating in Antarctic Research and systematic exchanges of research workers have been arranged.

Today, scientific research in Antarctica has been given recognized status by the Antarctic Treaty, ratified by the twelve powers which sent expeditions during the International Geophysical Year. Freedom of scientific research is guaranteed for a period of thirty years; the contracting parties bind themselves to use the treaty zone--delimited by parallel 60 degrees S. - for peaceful purposes only, to ban nuclear explosions, not to dump radioactive waste in the area, and to exchange their programmes and results.

This is the first treaty to protect scientific research and leave a non-governmental organization - the Scientific Committee on Antarctic Research set up by the International Council of Scientific Unions - full latitude to lay down programmes. It constitutes a precedent, and is a step towards finding a concrete formula for the relations between science and governments. And, by a happy paradox, the continent that is most hostile to man is the one which will do most for the cause of peace."[1]

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[1]Extract from: The Polar Ice-caps IMPACT. Vol. XIV, No. 4, 1964 (UNESCO) By A. Bauer and C. Lorius

Phase 5. Usually phrased as 'end' products - there are in effect no end products but only the contact instruments of industrialization's human ecology services which are the plug-in or latch-on terminals of service industries, e.g., the telephone, transportation and and other communication units, the motel (bathroom and bed) - and eventually the world-around environ control service unit. (R. B. Fuller, 1964)

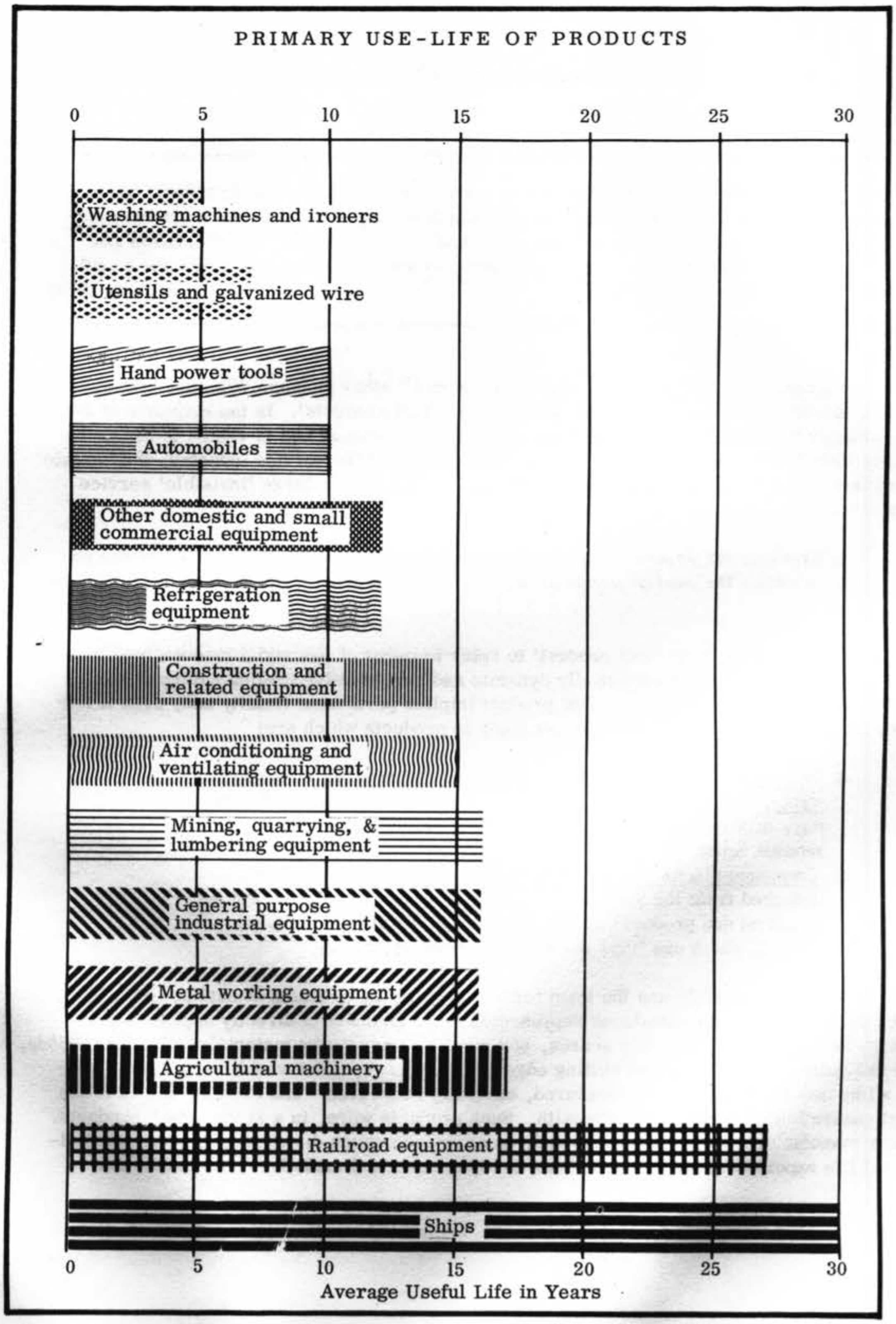
Each phase of the program interweaves with all other phases. We have already dealt then with various aspects of the 'evoluting contact products'. In the evolution of the tool towards the industrial tool complex, control and functional use is vested in the remotely linked 'contact' instrument. In the development of the service industry, the 'visible' terminals are various facilities which allow man to 'plug-in' to large 'invisible' service networks.

In directing our present discussion, therefore, towards the fact that there are no end products within the overall process, we may further clarify various aspects of our design direction.

The use of the term 'end product' to refer to items of industrial manufacture implies a lack of recognition of the essentially dynamic and regenerative cycling nature of the industrialized production process. End product implies permanent finality and, even if this were theoretically possible, it would not apply to products which are:

a) Wholly temporal 'use' configurations in a particular consumption cycle, e.g., the metals forming an auto, which is being driven today, may be reprocessed and refunctioning in a refrigerator six months hence.
b) Component parts of an overall system only with no use value detached from the system, e.g., the domestic telephone hand set is not an end product but only the specific local end of a wire through which one 'taps in' to the telephone network.

We might possibly use the term for the handcrafted products of earlier periods, when such items as were produced represented large amounts of directly applied human energy and the use of relatively scarce, and often 'precious' raw materials. In such periods, the difficulty of securing a fine cutting edge or really sharp point would make a good knife or a fine needle, objects to be treasured, carefully preserved - and even passed on to the next generation as accummulated wealth. Such products were, in a sense, 'end' products. Their manufacture took a long time, and, as embodying much direct human labor and individual life experience, they were unique, irreplaceable and made for 'permanent' use.


PRIMARY USE-LIFE OF PRODUCTS
0
5
10
15
20
25
30
Washing machines and ironers
Utensils and galvanized wire
Hand power tools
Automobiles
Other domestic and small commercial equipment
Refrigeration equipment
Construction and related equipment
Air conditioning and ventilating equipment
Mining, quarrying, & lumbering equipment
General purpose industrial equipment
Metal working equipment
Agricultural machinery
Railroad equipment
Ships
Average Useful Life in Years

There has typically grown around such products traditional associations of intrinsic value, and particular attitudes of aesthetic response, which are related to the above factors. In architecture, slogans like 'truth to materials', 'form follows function' etc. are also traceable to such earlier attitudes.

With the advent and swift development of industrialized mass production, almost all of these earlier traditional attitudes to material products became irrelevant when applied to the goods produced by the machine. For the first time, man could produce objects of common utility in huge numbers. New tools, made of new alloys, had a precision and use-life far in advance of any previous handmade product and were produced in a fraction of the time - with relatively little direct investment of human energy. When manufacturing technologies went over into the 'invisible' ranges of electrical and other radiation energies, this also had its effect on the 'end' product. For example, the electric light bulb is a contact instrument for 'tapping in' to remotely generated energies, and has little or no 'intrinsic value' apart from its direct function.

Previous attitudes to materials, forms and functions were no longer adequate to a situation in which with new alloy and chemical strengths 'function' relative to 'material' and form, was no longer accessible to the unaided vision. The fine steel cable might look more fragile than a heavy iron bar but was many times stronger and more efficient. Truth to materials could no longer be tenable when it became possible to produce materials to any particular strength or 'truth' required. There is no real 'value' divisions between naturally occurring 'organic' materials and those synthesized by man, when it is realized that organic or synthetic materials are both local rearrangements of the basic elements inventory.

No accummulations of machine products could really be considered wealth when the industrial cycle of manufacture--performance--re-use--improved performance provided a constantly evoluting product at lower costs and higher performance with each successive cycle. The primary use-life of products tended to shorten and many shifted over into being expendable after a single use.

The real nature of these fundamental changes in the production of 'wealth' - the shift from an agriculturally based margin survival of some to industrial abundance for all - is still not wholly understood today. As industrialization developed, conflicts over the 'accounting' systems for the accumulating wealth and its increasing inequality of distribution led to the various political and ideological blocs. Lack of insight and accompanying inability to 'handle' the swiftly developing phases of industrialization brought on the 'crashes' and 'depressions' of the between-the-wars periods with their various remedial action programs. Gold, a typical 'symbolic' example of pre-industrial wealth which no longer had any functional validity, was also abandoned as a currency backing during this period - with much mystification and reluctance. Significantly related, however, to this obsolescence of one wealth standard by man was the unobtrusive acquisition of another - the completion of the atomic table of 92 elements in 1932. At the time when society seemed to be going off the rails, the 'invisible' inventory of man's real wealth resource - his ordered and accumulated knowledge - was given an extraordinary increment!

With the coming of automation, industrial productivity itself loses its main role as primary activity in society. The production and distribution of goods no longer assumes prior importance. It is now accomplished with less energy and material investment, less direct involvement of human beings, and becomes a relatively effortless machine procedure.

The 'evoluting contact products' produced in abundance and variety by the machine have no intrinsic value other than their immediate use value in subtending human function. Material 'wealth' may now be created with such ease that even the notion of these being a constant 'surplus' to normal requirement may also be considered 'normal'.

Man has, however, only recently emerged from the 'marginal' survival of pre-industrial society which was based on the economics of scarcity and where manufactured products were unique and irreplaceable. He cannot quite become used to potentially enormous wealth of an automated industrial society in which the only unique and 'irreplaceable' element is man himself.

This is one of the main points about automation and is worth re-emphasizing. In a 'margin survival' society, objects, products, resources etc. tended to have more importance in sustaining the societal group than the individual, man. (Hence our still laggard pre-occupation with wealth as property owning, i.e. owning the means of survival.) Man was, in a sense, used most prodigally in order that the idea of man might survive. The material object was unique - man was expendable. Value resided in objects, systems, properties as 'ideal' and 'enduring', therefore, external to individual man.

Now through developed industrialization, the object, may be produced prodigally - the product is expendable - only man is unique. In fully automated process the only unique resource input is information - that which programs the machine production performance. The products are non-unique and expendable, i.e. as are the machines and the materials acted upon by the machines. The machines may be re-made exactly by other machines which contain the necessary information input. The materials are the basic physical elements temporally structured into various use combinations by acting upon them with information: they are recycled and restructured through various uses by further information. The only part of the whole process which is non-expendable and 'unique' is man - individual man and his impounding of the accumulated knowledge of all men.

It may be underlined that one major block in our understanding centers around this lack of insight into the nature of technological process. In 'tool evolution' we have traced the regenerative performance cycle. Technology 'does more with less' to the point where in micro-miniaturization the actual product is almost invisible. The fundamental trend in industrialization relative to society is not simply to increase the material paraphernalia of living but rather to progressively dematerialize such means. The trend is, therefore, towards the ultimate ephemeralization of all man's environment control facilities - to render them invisible. This means taking less of man's life time, life energy, and space to deal with the day-to-day 'survival' requirements of controlling, monitoring and arranging the material environment to his necessary purpose.

As technology progressively 'compacts' the means for such environmental control through increased performance per unit of invested resource, it also enormously expands man's potential - his access to, awareness of, and capacity to use life itself, in full interaction with his past heritage and presently evolving world society.

Many of those professedly concerned with what they view as 'a growing dichotomy of spiritual and material values', signally fail to appreciate this inherent trend. Their dichotomy tends to be internal, subjective and at some remove from reality. In describing a visit to a learned colleague, one author recently gave a good illustration of such an attitude, -

> 'He sat in an air-conditioned study. Behind him was a high fidelity phonograph and record library that brought him the choicest music of three centuries. On the desk before him was the microfilm of an ancient Egyptian papyrus that he had obtained by a routine request through his university. He described a ten-day trip he had just taken to London, Paris and Cairo to confer on recent archaeological discoveries.
> When asked what he was working on at the moment, the professor said, An essay for a literary journal on the undiluted evils of modern technology.'[72]

An important aspect of the world industrialization is that in the diffusion of its products, particularly those which are the 'contact instruments' of the world communications network, common cultural attitudes and values are also diffused.

Culture may be defined as a distinctive pattern of living, whose shared components are attitudes, values, goals, institutions and modes of communication. These would also include the 'style' of living as influenced by those man-made environment control elements and products in common usage.

The important 'reality' of our present world social and cultural situation is that a world society has been brought into being, and an international culture now exists - albeit, at many different stages of growth and development. It has been pointed out that though <u>politically</u> the world has never been so sharply divided, <u>culturally</u> it has never presented it has never presented such an unified appearance.

This has been brought about by various factors all of whom are, in one way or another, aspects of the development of man's world 'services' network. They are the product of developed industrial technologies and are dependent on the evoluting contact instruments, support networks and terminal service facilities for their maintenance. We may summarize some of these factors as follows:-

1. <u>The growth of international scholarship</u> and of the organs of scholarly exchange - the transnational conferences, radio and tele-casts, journals and papers, and the large-scale world cooperative ventures, such as the International Geophysical Year, etc. The increased mobility and migration of scholars is also evident and important, and the role of the various growing world organizations.

2. <u>The expansion of swift global transportation</u>,
   a) carrying around the world the diverse products of mass production technology provides common cultural artifacts which engender, in turn, shared attitudes in their requirements and use. That the transistor radio, T. V. aerial and the 'soft drink' are more widely distributed and more swiftly encultured than 'common ideals of justice, respect for human values and institutions' etc., is not evidence that the latter are less communicable but that much less attention and energy has been put into their circulation.

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[72] 'Self Renewal' by John W. Gardner, Published by Harper and Row. 1964.

b) The common service facilities and standards of transportation terminals, aircraft and their associated equipment, plus their support systems of hotels, motels, restaurants and other services. The travellers, or inhabitants of any of the world's large cities - London, New York, Tokyo, Paris etc. - is more likely to find himself culturally at home in any of them than he may feel in the rural parts of his own country. The availability of the international cultural environment which sustains him will be more evident.

c) The generally increased mobility of man. We may discern in world tourism a developing ecological pattern of man which is part of a new international education process. This is likely to be further accelerated with the spread of automation and the new availability of 'non-work' time. Apart from the cultural diffusion and interchange which this occasions, we find associated with it a renewed interest in man's past cultural heritage, and in the natural environment. The large-scale restoration of historical sites, of whole towns and areas, are expansions of the 'museum without walls' concept, which is likely to go forward in a greatly increased manner, with man's dual expanding interests in both his past and emerging future.

3. The communications revolution, whose latest benchmark is the world orbiting comsatellite, diffuses and interpenetrates local cultural traditions, and generates commonly shared cultural experience in a manner which is unprecedented in human history. Within the world communications service network, the related media of radio, television, cinema, with magazines, newspapers and a range of allied products, virturally are a common cultural environment sharing and transmitting man's symbolic needs and their expression on a world scale. Should their standards and values appear, to some, to fall below that of previous and local traditions, it may be suggested that little attention has been paid towards understanding of the nature of this development - or towards eliciting appropriate standards for such media within the educational framework. By and large, this cultural evolution has proceeded with little positive leadership, understanding or encouragement from those concerned with the academic maintenance of cultural values and standards.

Through the above trends, and many others which have not been touched upon, there is demonstrated a growing awareness of the essential unity of man and his society, the continuity and interdependence of his cultural heritage, and the viability of a world fusion of cultures contributing to an overall increase and richness in human civilization.

WORLD - AROUND ENVIRON CONTROL SERVICE UNITS

In reviewing the present stage of the world services networks, we can see that the most advanced technologically are transportation and communication. The most laggard and least developed area of environment control still remains human dwelling facilities. The contrast has now become so glaring as to be insupportable,

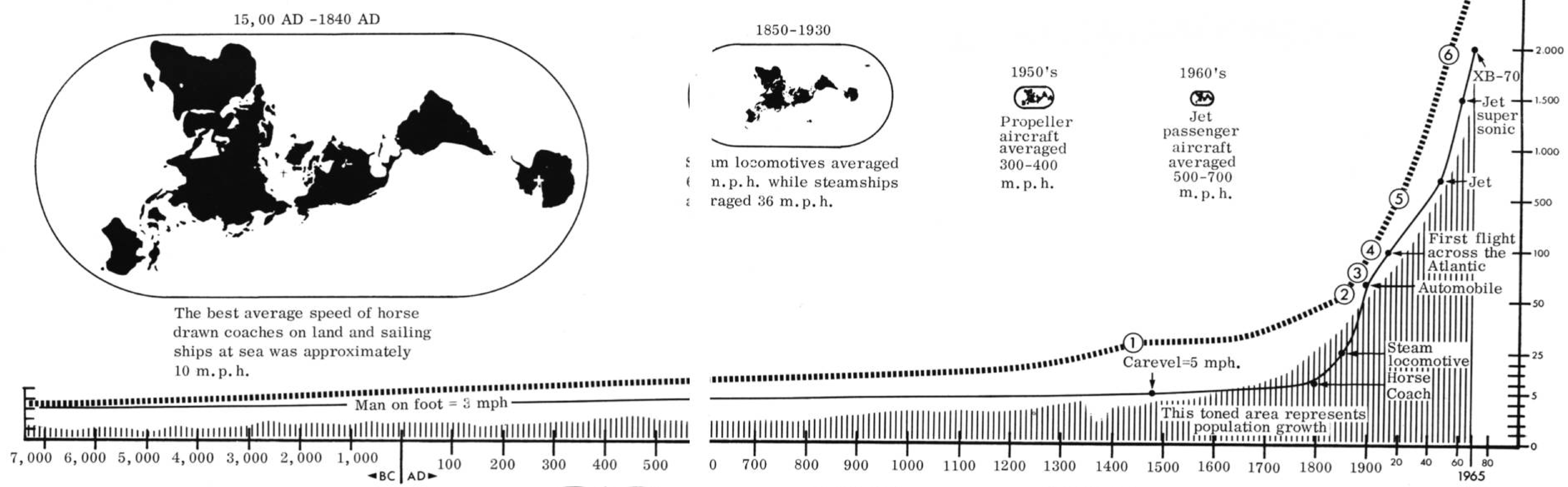
> 'We (now) see millions of glistening metallic T. V. antenna sprouting above the roofs of filthy, festering, bathroomless, firetrap living shacks - the world

SHRINKING OF OUR PLANET BY MAN'S INCREASED TRAVEL AND COMMUNICATION SPEEDS AROUND THE GLOBE

YEAR	500,000 BC	20,000 BC	300 BC	5(	3C	1,500 AD	1900 AD	1925	1950	1965
Required time to travel around the globe	A few hundred thousand years	A few thousand years	A few hundred years	A few te	of years	A few years	A few months	A few weeks	A few days	A few hours
Means of transportation	Human on foot (over, ice bridges)	On foot and by canoe	Canoe with small sail or paddles or relays of runners	Large sai oars, pac and horse	oats with nimals, ariots	Big sailing ships (with compass), horse teams, and coaches	Steam boats and railroads (Suez and Panama Canals)	Steamships, transcontinental railways, autos, and airplanes	Steamships, railways, auto jet and rocket aircraft	Atomic steamship, high speed railway auto, and rocket-jet aircraft
Distance per day(land)	15 miles	15-20 miles	20 miles	15-2	iles	20-25 miles	Rail 300-900 miles	400-900 miles	Rail 500-1,500	Rail 1000-2000
Distance per day (sea or air)		20 by sea	40 miles by sea	135 mil	by sea	175 miles by sea	250 miles by sea	3,000-6000 air	6000-9500 air	408,000 air
Potential state size	None	A small valley in the vicinity of a small lake	Small part of a continent	Large ar continent colonies	of a th coastal	Great parts of a continent with trans-oceanic colonies	Large parts of a continent with transoceanic colonies	Full continents & Transocean Commonwealths	The Globe	The globe and more

Communications	Word of mouth, drums, smoke, relay runners, and hand printed manuscripts prior to 1441 A.D.	① The Gutenberg 1441 printing press	② The 1863 new:	oid print Web per press	③ The Bell 1876 telephone	④ The Marconi 1895 telegraph	⑤ First commercial 1920 radio broadcast	⑥ National 1950 Television	⑦ Transcontinental T.V. with the introduction 1965 of Early Bird satellite

THE RELATIVE SIZE (THE WORLD AS TRAVEL TIME DECREASES



5,000 years of villages & towns

and then

5,000 years (300BC-1800AD) in whicl evolved into cities, and then into m | wns slowly opolises.

Rome was the only metropo of over 1,000,000 people fr this date forward until 1800).

Rome's population declined by 30,000

Bubonic plague wiped out 1/4 of Europe's population

For the first time in history it began to be safe for men to live in large cities because of advances in medicine and sanitation. Life was made more secure and comfortable by the Industrial Revolution & mechanized farming

Adapted from: (1) International Industrial Development Center Study. Stanford Research Institute (2) Science and the Futi | of Mankind. Hugo Boyko, editor. (Issued by World Academy of Art and | ience) Dr. W. Junk, The Hague, 1961. (3) Change/ Challenge/ Response. Office of Regional Development, Albany N.Y. 1964.

around. Thus we find ourselves continually advancing in domestic technology, but only as the second hand gadgetry, by produced by the cast off segments of the weaponry industry.'[73]

Within this phase of the program, a prime priority should be, therefore, the design, development, prototyping and field testing of environment control units. This would include the design of the services, maintenance, parts inventories and transportation performances required to make such rentable and fully maintained service operable around the world.

Little of the information required for such designing will be found in standard architectural works but will require the review, analysis and compilation of information from many different areas of advanced technology.

Close examination and analysis of the 'network' principles of the present world services of airways, telecommunications will be a valuable guide. A wealth of material may be found, also, in the technical and logistical operations manuals of various naval, air and land services - particularly those concerned with operations in the polar regions, under sea exploration and the other 'inhospitable' and extreme environ conditions.

The scientific and technological knowledge, the detailed generalized systems information, the performance characteristics of the metals, plastics and the various advanced aircraft and airspace components etc. is freely available in the libraries and technical information services of most nations. All that is required is the requisite design initiative to engage with the enterprise!

We have touched upon many of the varied aspects of human dwelling requirements in the various chapters of our discussion. Students are recommended particularly to look closely at the 'Universal Requirements for a Dwelling Advantage of R. B. Fuller'.[74] They will find this the most comprehensive attempt to list every requirement, and meet most contingencies, likely to occur to man in relation to dwelling. As a working schedule it methodically lists, in detail, the whole concept of advanced dwelling as an energy controlling valve, operating on a frequency modulation basis; the structure enclosure performance requirements; analysis of the internal mechanical and other energy exchange services; the communication aspects of dwelling; and its collective, global performance as a world service facility. The 'Universal Requirements' schedule also assumes, -

> 'that the design level of each progressive model will be obsolete within a period of somewhere between 10 and 15 years, and, therefore, that the older apparatus will be continually withdrawn from circulation, the materials to be scrapped and reprocessed, with appropriate addition from new resources, into advanced mechanical standards - thus instituting a world industry which will continually reprocess the dwelling facilities of the world's people.'[75]

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[73]"Ideas and Integrities" by R. Buckminster Fuller, Published by Prentice Hall, 1963.

[74]Document Two (1964) 'The Design Initiative' - R. Buckminster Fuller

[75]Flow Diagram into Tomorrow - R. Buckminster Fuller, unpublished, 1941-42.

As we have discussed certain of the 'cultural' aspects of technological development, it may be useful to comment upon these relative to dwelling. Traditionally, a great deal has been made of the cultural barriers to change in this area. The home/family dwelling is indicated as the basic unit of enculturation most resistant to those changes in form, in equipment or services which might disturb or invalidate its social core function. It is suggested that certain forms are culturally embedded, and may not, therefore, be altered, that various certain local usage must be designed for.

In establishing design criteria for a dwelling which would be globally operative, it is obvious that such cultural qualifications be treated respectfully. Designs should be flexible enough to accommodate specific cultural preference. Insufficient attention is generally given in dwelling design to the cultural and social functions of space, privacy, acoustic levels, etc.

However, it should be noted that the strength of many apparent cultural barriers, to the swift acceptance of the products of advanced technology, do not appear to be as measurable strong as they are traditionally stated. Electricity, the telephone, transistor radio, and television could not be more eagerly adopted wherever they have been made available; even in the most traditionally oriented or primitive cultures. We may note also that, in the so-called advanced cultures, a great number of technological services have been incorporated within the family dwelling or, have displaced home functions to external agencies, in the term of one generation. In the same period, one such traditionally hallowed 'core' function - the open fireplace, culturally embedded as the home 'hearth' focus, has disappeared - only to reappear in a more technically refined guise as an optional 'luxury' extra!

One may state, then, in relation to long-term design and performance criteria, that cultural characteristics tend to variable, local and plastic. Much less than one generation may suffice for gross cultural change. On the other hand, physical characteristics and acquirements are relatively invariant, universal and fixed for many generations. Generally, we need to recognize that the world environ control service unit must be designed so as to accommodate those needs of individual man beyond the physically measurable - for the fullest range of individual realization - as allowing any kind of living within its adjustable and controllable domain.

Against this concept of the scientifically designed environment control embodying the fullest and most flexible individual control, we have the 'market oriented' standard of the traditional craft builder and prefabricator. His plea has been that 'fully industrialized housing' will destroy individual living and produce conformity. The average handcrafted or pre-fabricated dwelling in most of our presently 'advanced' suburbs are an object lesson in cabinned conformity and mass design, tailored to a mythical consumer.

Environment control facilities of the most fully advantaged design may now, in terms of available automated production technology, be produced, not only in the vast numbers required, but with any requisite variety of major or sub-assembly configuration, 'finish', alternate and flexible space, atmospheric, communications and energy controls.

The availability to all men of the high standards of living now only enjoyed by less than half of the human family is perfectly feasible through our present level of scientific and technical knowledge. It is the central task of the World Design Science Decade to design the ways and the means through which this may be accomplished. No mandate is required, other than personal initiative, self-organized and self-coordinated on a world around basis.

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