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 (1963) Document 1

INVENTORY OF WORLD RESOURCES HUMAN TRENDS AND NEEDS

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

INVENTORY OF WORLD RESOURCES, HUMAN TRENDS AND NEEDS

Phase I of five two-year increments of World Retooling Design Decade proposed to the International union of Architects (I. U. A.) in order to render the total chemical and energy resources of the world , which are now exclusively preoccupied in serving only 44% of humanity, adequate to the service of 100% of humanity at higher standards of living and total enjoyment than any man has yet experienced.

World Resources Inventory
Southern Illinois University
Carbondale, Illinois. USA

This Phase I study was compiled at Southern Illinois University, July - September, 1963, by the following group:

Research Professor		R. Buckminster Fuller
Research Associate (Executive Director, Project)		John McHale

Members of Research Team

Walter K. Brown	B. A. (Physics)	Dept. of Physics (S.I.U.)
David Day	B.S. (Design)	Dept. of Design (S. I. U.)
Ken R. Gramza	B. A. M. Sc. (Design)	Dept. of Design (S. I. U.)
Tony S. Gwilliam	Dip. Arch. Nottingham, U.K.	Dept. of Design (S. I. U.)
Carl G. Nelson	B.A. (Design)	Dept. of Design (S. I. U.)
Leo H. Takahashi	B. A. (Physics)	Dept. of Physics (S. I. U.)

Secretary

Mary L. Holderman	3rd yr. student in Education	Dept. of Education (S.I.U.)

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In general, references are given for charts and tables where these have been wholly extracted from a few sources. Where no reference is given, material has been compiled from a number of sources. The World Resources Inventory Office, S.I. U., will gladly supply detailed reference sources on request.

Maps used in this report are based on the Dymaxion Air Ocean World Projection of R. B. Fuller. This projection shows the world land mass as one island, in the air:ocean , with minimal distortion of true geographic scale.

PREFACE

This report originates with the proposal made by R. Buckminster Fuller to the International Union of Architects (I. U. A.) at their VIIth Congress in London, England in July, 1961. He proposed then that the architectural schools around the world be encouraged by the I. U. A. to invest the next ten years in a continuing problem of how to make the total world's resources which now serve only 40% serve 100% of humanity through competent design despite a continuing decrease of metal resources per capita.

The formal text of this proposal, as finally agreed upon by the I. U. A. Executive, which acts on behalf of its sixty-five member countries, is given immediately following this preface. In essence, it suggests that world architectural schools should initiate, as part of their curricular work, a beginning survey of the total resources now available to man on a global scale, a first stocktaking of what man has to do and what he has to do it with! Such a stocktaking would be their preliminary phase of an overall plan concerned with the 'designed' use of our total global capacities in the service of all men. The results of this continuing program would be exhibited every two years at the successive Congresses of the I. U. A. which are held on each occasion in a different host country.

After meeting with the VIIIth International Conference of Students of Architecture in Barcelona, June, 1963, Fuller reported that, "The students were in agreement with my conclusion that if the world resources inventory had to be made by the students' own uncoordinated efforts at separate schools around the world that my whole world redesign program would become impractical. Because I have had a third of a century experience in such inventorying, in 1927 for my own 'account, in 1936 for the World's Copper Industry, in 1940 for "Fortune" magazine's tenth anniversary, U.S. A. and the World issue and in' 1943 for the U. S. A. 's Board of Economic Warfare, the students were enthusiastic over the announcement that Southern Illinois University and I are preparing the resources and trends data from which the design program will emanate".

The present report is intended as an introductory step towards the **stud** undertaking and will form part of the overall presentation of the world planning proposal to the VIIth Congress of the I. U. A, in October, 1963. It does not purported to be, in any sense, a complete review of man's resources or his needs, but is intended merely to provide a swift comprehensive glance at certain of the **fundamenta** trends in man's present relation to his environment, and to indicate broadly how **thes** trendings may relate to the forward task of assessing more completely man's present and future needs. Its final concern is with the designed utilization and maximal **employm** of our vast technological resource in ways commensurate with the social and cultural well being of the world community.

This is a problem which may not be solved either by political strategy or by private enterprise though both function in the realization of the world students' initiative. The latter's world retooling design, as transcendental to both political

NEW FORMS VS REFORMS

(extract from a letter to World Architectural Students by R. Buckminster Fuller - complete text on page 51 of this report.)

"There are two main classes of tools. Those which are designed to increase life's mental and physical advantage and degrees of freedom such as gears, pencils, books, and prime movers, and those which are designed to decrease the advantage and degrees of freedom of those who inadvertently encounter them; e. g. - traps, prisons, weapons, etc. The first class may be identified as the positive tools and the second as the negative tools. They may also be classed as Livingry and Killingry - or as life-advantaging or life-frustrating tools, respectively. All tools may also be divided into two other main classes -- the craft tools and the industrial tools - craft tools are all the tools that can be produced by one man starting nakedly in the wilderness without knowledge of any previous tools existence, e. g. - bows and arrows, stone chisels. The industrial tools are all the tools made by other tools which cannot be produced by one man as the Queen Mary or a modern hydro-electric dam or a modern motor expressway. The word was the first industrial tool by virtue of the word all the experiences of all men in all history began to integrate. Man is unique amongst animates in the degrees of incisiveness and magnification to which he has demonstrated an accelerating capability to alter his ecological patterning about the earth by altering the nature of his environmental controls -- structures -- a&metabolic process facilities -- mechanics -- as a progressive extroversion and severance of his integral, or corporeal, functions.?"

and commercial expediency, must effectively implement the industrial system metabolics of a world man ecology. Such design need only convert the overall mechanical efficiency of the world industrial network from its present realized 4% to 12% in order to render all mankind a total success.

The present first phase report, then, gives an initial presentation of man's world resources, and relevant forward guidance material, as a catalytic agent towards the world students' direct implementation of the planned use of these resources. Though their design planning may be innocent of an enabling authority, its existence as presented and progressively circulated will eventually induce world emergency recourse to its effective solution of fundamental world problems.

It is obvious that the first years world planning will show much fumbling and inadequacy. Criticism will come, not only from the architectural profession, but also from politicians, economists and industrialists. Such criticism, however, will be of great value in accelerating the further years' comprehension of the problems and their design solutions.

Such supra-national planning in no way duplicates the work of agencies like the U. N., UNESCO , World Health Organization, etc., and of the various international conference bodies of scientists and technologists, but assumes a designing and planning initiative which would be integrative of data and reports already compiled by such bodies.

Within the report itself, the text generally is used to set the background for linkage and interpretation of the graphs and charts which in many cases communicate their main import without additional commentary. As this printed version forms only a part of the complete presentation of the theme to the I. U. A. Congress, detailed analysis and discussion of each main section has been kept to a minimum, else the document would have become too unwieldy for use.

In the charts and text which comprise the main body of the report, emphasis is placed on numerical quantity or cumulative linear increases in resource employment, manufacture, distribution, etc. It should be stressed, however, that this material emphasis does not obscure the prime fact that our basic resource is MAN and his knowledge. All other cultural and technical advantage referred to, and expressed in various ways, is no more than the physically objectified, but truly invisible intellectual resource of all men as displayed in the progressively accumulated array of knowledge of discovery and invention. It is through this resource that man has maintained himself on earth.

John McHale
Carbondale, Illinois
September, 1963

Proposal to the International Union of Architects By R. B. Fuller

INTERNATIONAL UNION OF ARCHITECTS

INTERNATIONAL EXHIBITION AMONG STUDENTS OF ARCHITECTURAL SCHOOLS

This International Exhibition was created in 1951 by the French Section of U. I. A. in co-operation with the Ecole Nationale Superieure des Beaux-Arts of Paris.

At the Hague Congress in 1955, the Board of the Ecole Nationale Superieure des Beaux-Arts kindly entrusted the U. I. A. with the organization of future Exhibitions.

The special committee appointed by the Executive Committee is proposing the following theme to the Universities and High Schools of Architecture for the International Exhibition of 1965 :

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.
THE WHOLE SO DRAMATICALLY PRESENTED THAT IT MAY EVIDENCE THE MAJOR LOOMING WORLD SOCIO-ECONOMIC PROBLEMS MOST EFFECTIVELY SOLVABLE BY UNPRECEDENTED PHYSICAL DESIGN STRATEGIES AND THE RELATIVE SEQUENCE OF NECESSARY STEPPING STONE DESIGN SOLUTIONS, THE PROGRESS - IVE SOLUTIONS OF WHICH MAY BECOME THE SUCCESSIVE PROBLEM ASSIGNMENTS OF A TEN YEAR SERIES OF U. I. A. STUDENT DESIGN PROGRAMMES.

This theme will be the motive in each country, and for each School and University of a programme the research for, and drafting of which, will be under the Professors' responsibility.

The entire world's industrial resources are now preoccupied in serving only 40 percent of humanity with the advancing standards of living exclusively provided by the world's progressively enlarging and integrating industrial networks. Making the world's totally available resources serve one hundred percent of an exploding population may only be accomplished by a boldly accelerated design evolution which adequately increases the present overall performance per units of invested resources. This is a task of radical technical innovation rather than political rationalization. It is a task which can only be accomplished by the world's architects, inventors and scientist/artists. The engineer has been deliberately trained by society to be an unquestionable authority: an engineer must not invent for his authority is thus violated.

Since aircraft and space technologies are already operating at high levels of performance per units of invested resources, the recent decades realization, that space can be enclosed for environment controlling purposes with approximately one percent of the weight of resources at present employed by the conventional building arts for a given task, indicates that the conversion of the world resources from their present service of only 40 percent to service of 100 percent of humanity is to be uniquely effected within what may be called the "livingry" arts in contra-distinction to the "weaponry" arts. The latter alone up to this moment in history has been benefited directly by the highest science and technology. Any and all improvements in the home front's peace extending "livingry" advantage have been post-weaponry byproducts.

This brings the solution of the forward "livingry" design problems into direct focus as the responsibility of the architect (as the only technical profession concerned with "putting things together" in an era of the increased fractionation by intensive specialization). Since the practicing architect may operate only when funded by a client and there is no apparent client to retain the architect to solve this world problem, it may only be solved by the world architects taking the initiative, as have the medical scientists, in the development of a comprehensive anticipatory design science dedicating at least its next ten years to making the total world's resources serve 100 percent of humanity at higher standards of living than hitherto experienced by any men through competent industrially producible design-rather than leaving the evolutionary advance to political reforms catalysed by accelerating frequency of world political crises. Because the economics of the architectural profession, at present, precludes the devotion of adequate time and resources to the solution of this task by the graduate practicing architects, it is in evidence that the architectural profession may activate this comprehensive anticipatory design initiative through encouragement of its professional university schools of architecture to invest the extraordinary intellectual resources and available student time within the universities to the establishment of the design science and its application to world planning. This is to be inaugurated with a ten year sequence of joined world architectural schools annual programmes organized for the progressive discovery and design solution of the comprehensive family of economic technical and scientific factors governing such a world planning programme.

Several dramatically communicated solutions come immediately to mind such as the use of the total facade of a skyscraper or a mountain cliff. The following is an example of a satisfactory solution: - the design of a 200 foot diameter Miniature Earth. This Minni-Earth could be fabricated of a light metal trussing. Its interior and exterior surfaces could be symmetrically dotted with ten million small variable intensity light bulbs and the lights controllably connected up with an electronic computor. This whole Minni-Earth array could be suspended by fine high strength alloy wires from-masts surrounding Minni-Earth and at some distance from it. If the sphere were sus-, pended 200 ft. above the ground, the wires would become invisible and it would seem to hover above the earth as an independent asteroid. At 200 ft. minimum distance away" from the viewer, the light bulbs' sizes and distance apart would become indistinguishable as do the size and distances between the points in a fine half tone print. Patterns intro-duced into the bulb matrix at various light intensities, through the computor, would create an omni-directional spherical picture analogous to that of a premium television

tube - but a television tube whose picture could be seen all over its surface both from inside and outside.

Information could be programmed into the computor, and "remembered" by the computer, regarding all the geographical features of the earth, or all those geographical features under a great variety of weather conditions. How 'exquisite the geographical data may be is appreciated when we realize that if we use the 35 m. m. contact prints of the photographs taken by the-aerial surveyors at their lowest altitude of operation in which individual houses, as homes of men, may be discerned by the naked eye, and paste them together edge to edge on a sphere large enough to accommodate them in their respective geographical positions, that sphere would be 200 ft. in diameter-the size of our hypothetical Minni-Earth. Man on earth, invisible to man even from the height of 2,000 feet, would be able to see the whole earth and at true scale in respect to the works and habitat of man. He could pick out his own home. Thus Minni-Earth becomes a potent symbol of man visible in Universe.

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 computor's memory and acceleratingly pictured around the surface of the earth. The total history of world population's progressive positionings, waxings and wanings, individual and popular migrations and redeployments could be presented and run off acceleratingly in minutes, disclosing powerful eastward, westward north and southward swirlings, thickenings and thinnings, with a centre of gravity momentum of such trendings as to permit the computor to surge ten or one hundred years ahead providing reasonable probability for the planner/designer's anticipatory advantage. So could all the patterns of man's removal from earth's crust of the various minerals, their progressive forwardings and temporary lodgings in various design occupations such as in buildings, ships, railway systems and factories and their progressive meltings-out and scrapped drifting into new design formulations in other tasks and other geographies. (While the U.S. A. has no tin mines, its temporary scrap resource of tin continually re-employed in the aircraft industries mass production soft tooling gives the Western United States aircraft factory localities larger tin "mines" above ground as tin ore reserve than the ore reserves still within the mines in any one of the three large tin ore countries Malaya Straits, Bolivia or Tanganyika).

Cur hypothetical Minni-Earth, which the world architectural students may if they wish employ as their design facility, should be located as a major world city's focal design structure, analogous to the Eiffel Tower in Paris, as a continuing feature of World Olympic Games, to be reinstalled at each successive world site or Minni-Earth might be suspended from masts mounted on the ring of rocks in midstream of New York City's East River one quarter mile distant from the great East face of the United Nations 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".

Designs should provide for computor housing remote from the sphere, and for ferries, bridges, tunnel or other approaching means to a position 200 ft. below the Minni-Earth's surface from which point mechanical means, such as elevators, will transport large numbers of people upward and into the sphere to *a* platform at the Minni-Earth's center from which, at night, individuals would be able to view stars in the heavens seen through the lacy openings of the Minni-Earth, giving them the same orientation that they would obtain if they could go to the center of the real Earth and could look out with X-ray vision to see those very same stars seemingly fixed above specific geographical points of the Earth. (A star seen in zenith over Budapest as in zenith over that city at that very moment). A press of a button would show the Minni-Earth central observer the position of all the satellites which men have now sent aloft and though their circling of the earth is as slow as the circling of the hands of the clock and is therefore invisible, the touch of another button could accelerate their motions so that their total interactions and coursings for a period of years to come could be witnessed in a minute. (A bank of cloud lying apparently motionless in America's vast Grand Canyon was photographed over a long period of time by a cinecamera and the resultant picture accelerated into a one minute sequence. To the surprise of the original viewers of the seemingly still scene a very regular pattern of waves such as those on the surface of a coffee cup in a railway dining car ***was*** seen to occur in the cloud surface between the Canyon walls.)

If the students choose to employ Minni-Earth as their facility they will find the United Nations rich in economic, demographic and sociologic data. They will find the latest publications on the International Geo-physical Year rich in data that may be dramatically displayed on Minni-Earth - for instance an accelerated historical sequence of all the world's earthquakes would give startling indications of further recurrences. The world's electromagnetic field patterns, the varying astrophysical patterns would each provide spectacular Minni-Earth displays,

The students should consider their Minni-Earth as a 24 hour visual phenomena, in contradistinction to the conceiving of buildings as visible only in the daylight, a viewpoint which has recently been compromisingly altered by secondary lighting at night. The Minni-Earth sould disclose the world news and events on a 24-hour basis, its patterns being altered periodically for the disclosure of the long-time weather history integrated with the present forecasting.

The students will be greatly advantaged by the development of models of Minni-Earth at their own schools which could range from 10mm. to 30 metre in diameter. Photographs of data arrays on their models would be appropriate for their final project forwarding to the U. I. A. Congress exhibition.

In the development of the research for and design solution of this world pattern inventorying facility, the usual procedure in respect to architectural problems may, with the approval of the schools' professors, be altered so that the students will coordinate their activities as a team; meeting daily to consider the whole progress of the undertaking but deploying to perform their complementary missions in economic, technical, etc., data procurement and information gathering, processing and design realizations.

In the same way, within any one country, the schools might profitably divide up the many tasks in a manner appropriate to the special kinds of information most available in their respective localities or universities. If the students are willing the advantages of team coordination might be instituted between countries. The expansion of the rate at which the team coordination advantage might enter into the ten successive years of the world planning and design phases may develop its own logical pace, and students or universities electing to research and design the entire programmes themselves would undoubtedly demonstrate unique advantages accruing to concentrated effort and would also serve as experimental. controls for comparison with the results accruing to widely distributed coordinate team functioning.

The first year's design programme of all individuals, university teams, continental or intercontinental teams should all include prominent citation of the second and sequitur years looming high priority design problems most evidently essential to the accelerated adaptation of man to his evolutionary trendings through comprehensive anticipatory design science.

PROJECT

The professors of Universities or Schools will establish the detailed programmes themselves which will be proposed to their students.

The time dedicated to the study of the project will be fixed by the programme. It depends upon the organization of each School's teamwork.

NEW TECHNIQUE OF SCHEMATICS WITH SCHEDULES, etc.

The International Programme does not prescribe any particular drawing to provide; the choice is left to the professors. It is the same thing for the scale of these designs. The projects may be presented either in original drawing, or in any other way, under the condition that the sizes are kept (panels or shoots of 100 c. m. x 100 c. m.) - totalling 2 sq. metres rather than separate panels. The documents (drawings, photos, etc.) will be stuck on rigid panels (Isorel, light metal, or any other light material). The respective schools or students would be permitted to divide their total two square metres of surface into microfilm increments totalling that amount, and would consequently have to plan to install an automatic sequence operating microfilm projector at the 1965 U. I. A. Congress exhibition of the students work.

In the advanced technology which this world planning programme is meant to employ in direct benefit of livingry the parts production tolerances are held to sub-visible dimensions ranging from one one thousandth to one ten millionth of an inch. Unlike present architectural practices wherein prints of detailed drawings are translated by masons and carpenters into components with 1/4 inch errors tolerated, the advanced technology makes conceptually schematic drawings with schedules only of dimensions between. theoretical points. The dimensioning is subsequently scheduled into the production work by instruments and indexing machines, controlling dimensions far below man's direct discernment. For the bold new design evolution to win the initiative in employment of the world's prime resources on behalf of livingry from its preoccupation in weaponry will require the architectural students not only to employ the most advanced scientific

designing techniques, but also to adopt a progressive, comprehensive education in mathematics, physics, chemistry, economics, sociology and general history.

The ten year world planning and design's programming should at all times be considered in the light of its regenerative potentials. As with the calculus we cannot ascertain the second derivative's challenging prospect until we have differentiated our way through the first phases. It may be assumed that the first year's work when finally presented at the U. I. A. Congress will not only be of interest to world architects and students but that the results of their work will, for the first time, catalyse world attention and recognition of the significance and potentials of their enterprise. The regenerative consequences will probably be of surprising magnitude.

(Submitted to I. U. A. Executive by R. Buckminster Fuller)

MAN IN UNIVERSE

MAN IN UNIVERSE

At the outset, it is imperative that we assume man, the earth and the universe of which this forms a part, as our prime frame of reference. This fundamental relationship is our only relative constant. From consideration of such a comprehensive framework, we may proceed to those broad earth/man interactions and specific patternings which constitute our present position in time. Fuller has defined 'universe' as, 'the aggregate of all men's consciously apprehended and communicated experiences.' This operational definition allows us to consider man and universe as a manageable finite whole, about which all we can say and know is encompassed within the accumulated experience of all men – all recorded knowledge in the arts and sciences, all the thoughts, feelings and attitudes of all men, which constitute the intricate fabric of man's total evolutionary development on earth. We can comprehend this whole because it is, in essense, the macrocosmic version of each individual life experience. We are all, in effect, miniature universes. Each personal life and experience is a micro-universe.

In the overview of man/universe as the sum total of all of man's aggregated and recorded experience, each facet of this 'experience' is then a modification of universe. The velocity and magnitude of our possible modifications has only recently come within our ken, as we begin to glimpse, for example, the overall intricacy of some of the Earth's ecological balances. Our recent 'experiences' range in scale from changing a local climate by devastation of a forest, 'smogging' a city, increasing the percentile of radioactive material in the atmosphere, to creating miniature artificial suns and moons.

Our view of the dynamic equilibrium of these balances has only come about in the past hundred years as we began to grasp the concept of universe as a total energy process - entirely and ceaselessly in relative motion. As defined out of our experience this process is finite, and, as energy may neither be lost or gained within the system, all energy patterning occurs in cycles of regenerative transformation. Man, as integral with universe, exhibits congruence with such patterning and all his environment transactions, whether building, sleeping or plowing a field, form part of the total energy system. As all energy processes and events are thus in dynamic relation to all others, the fundamental pattern of these interactive relations extends through the immediately visible, or median, level of ordinary everyday life outwardly to the macroscopic level of the galaxies and inwardly to the micro and sub-microscopic levels of molecular events. We may now apprehend such vastly separated relations not merely as isolated happenings at different rates and sizes, but as related patterns occurring in various degrees of relative mobile frequency to one another.

It is apparent from this view that the nature of the whole system is such that the full range of an operating pattern may not be perceptible to us at the local level of its visible occurrence. The overall pattern is 'synergetic' in that the behavior of the whole may not be fully deduced from local examination of any of its sub-system components.

That the whole is not merely the sum of its parts is particularly evident to the chemist, who observes that the behavior of separated out, localized, elements never accounts for the associated behavior of the prior existent chemical complex.

This is important for us to bear in mind as we examine man's local patterning in his use of national resources, in his production and consumption cycling, and his local systems of ecological control.

The 'local' preoccupations of man with his immediately visible sub-cycles of the larger universal patterns has been largely responsible for the great lags and deadlocks which have occurred in his history. He tends to, 'back up into his future', with his vision circumscribed by his own immediate and apparently most urgent priority. The view of the larger pattern obtaining,removes the local 'insecurity' and can demonstrate vigorously that the only way in which to deal with the local problem is in terms of the whole, i.e., in our present series of world tensions it has become evident that 'national' security may only be part of man's universal security.

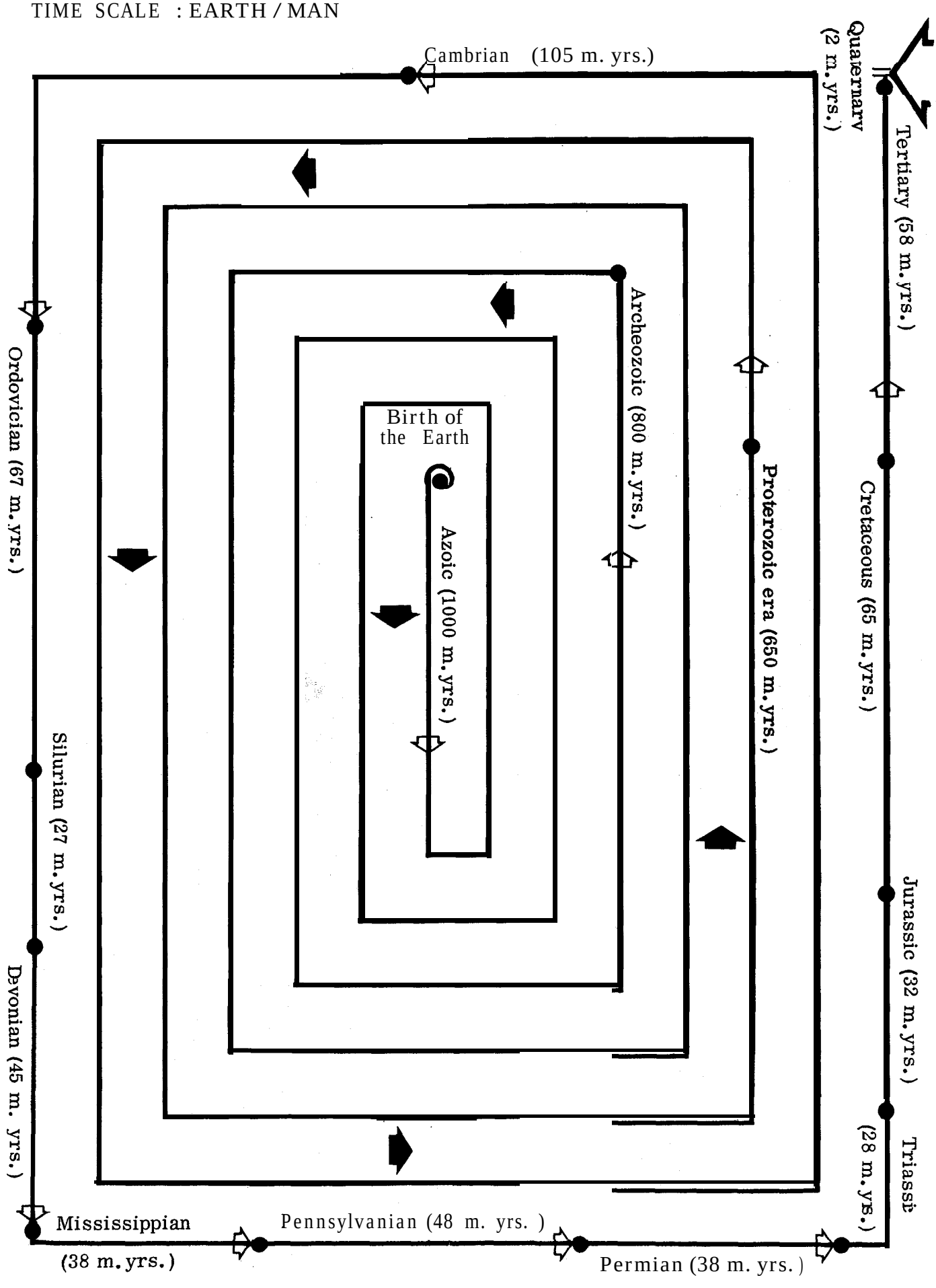
Man on Earth

Man, as we know him, is a comparative late-comer in the history of the earth and tenuous film 'of life which its surface has supported. In certain respects he is one of the most fragile of living creatures yet - in the manner of his explosive appearance on the scene, and the ways in which he has profoundly altered the environment within which he developed, he is the most powerful organism to have emerged so far.

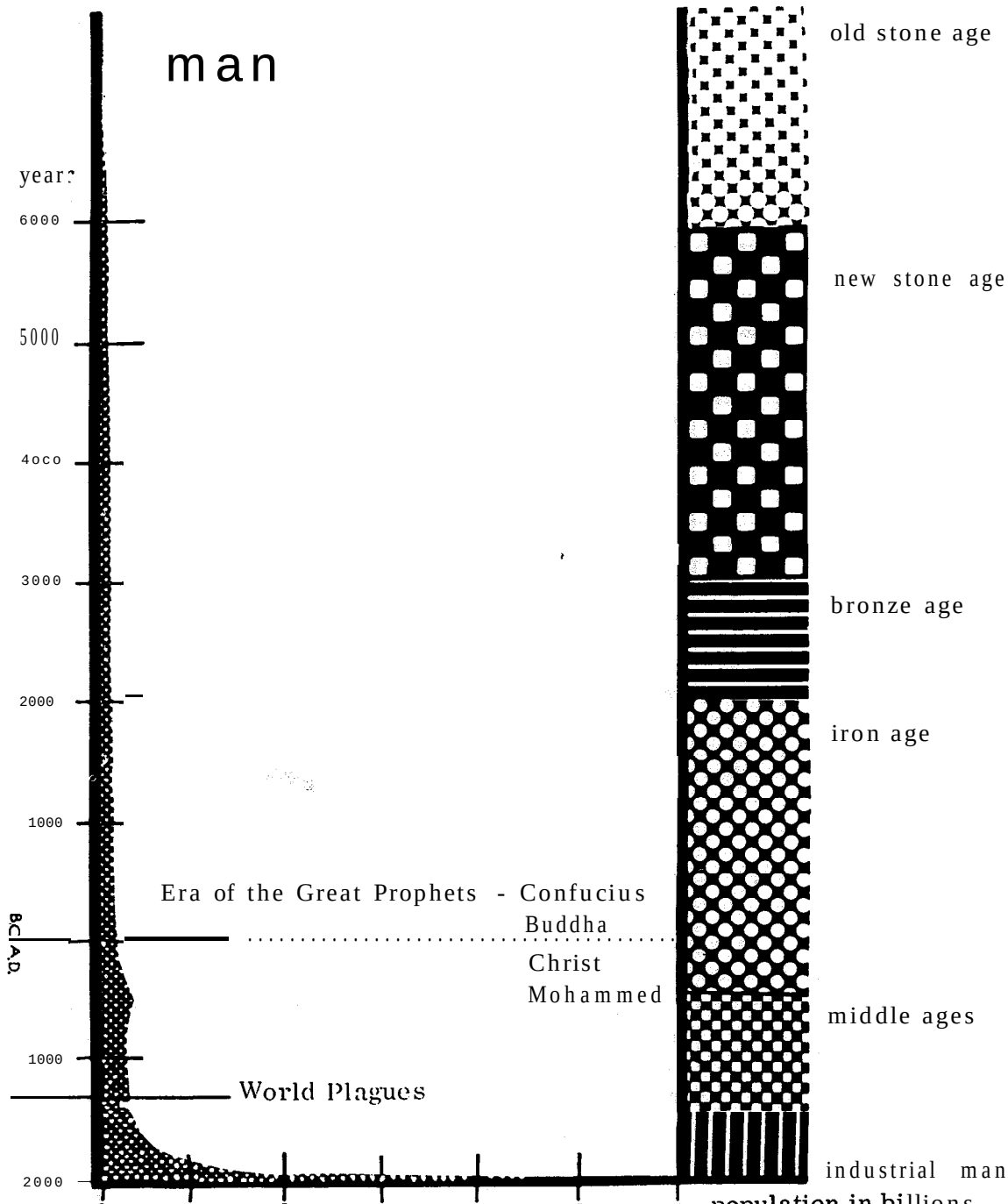
This 'power' to which we will often refer, (and indeed upon which this entire report is a commentary) is not visible physical power but rather the wholly invisible power of the brain. Linnaeus (Karl von Linne') the eminent Swedish botanist first gave the name Homo Sapiens to our present human strain. The wisdom or 'sapien referred to is not so developed in the traditional sense as we might desire, but,as intellect or brain power it is awesomely demonstrable.

Yet the difference between man and other organisms seems still only a matter of degree – of relative weight of brain, perhaps, and the number of its surface convolutions- but it is a marginal difference which is sufficient to alter significantly the way in which man has so far evolved. This difference has served to provide two main characteristics which set him apart from all other creatures. One is the ability to transmit his consciously accumulated knowledge from one generation to another and across many generations, and the other to externalise his organic functions into extent fabricated from his material environment - his tools. These features combined have enabled man, in spite of his relatively puny physical stature, to adapt himself or his environment, so that he has been able to survive severe climatic and other changes, and to spread swiftly out into every corner of the earth.

TIME SCALE : EARTH / MAN



WORLD POPULATION OF MATURE CREATURES & PLANT8



A.D. 1963	
MAN	3,115,000,000
Food + work animals	4,400,000,000
Water animal life	580.000.000.000,000
Wild animal life	1,667,000.000.000.000
Worms + termites	92.428. 683 GOO. 000.000. 000, 000, 000,000
Insects	3,146, 341, 600, 000, 000,000, 000, 000, 000,000
Protozoa + algae	70, 781. 761. 494, 767.278000000, 000, 000,000
Land Plants	721, 368, 396, 106. 333.000.000.000.000.000.000
Bacteria	2, 165,105, 198, 325, 000, 000,000, 000,000, 000,000

Relative Organic Population Figures from:
"World Balance Sheet" (see bibliography)

His capacity to transcend the temporal limits of his own life span by communicating his thought and feelings through many generations has given him an unique 'continuous' quality. Though his physical body may be entirely changed through cell renewal many times in his life and eventually be dissolved into its constituent parts1. In the sense referred to even the individual may be 'continuous', and the overlapping and interweaving of generations of communicating individuals make man, potentially, an organism which never sleeps, dies, or forgets.

The prime condition of **man's** survival, so far, has been this combined capacity to draw upon his own, and others'past experience to deal with the present, and to project this experience into provision for future contigencies - to anticipate and plan his future! The tools, whether words or stone axes, with which he gained direct survival advantage over other creatures, and through which he investigated his environment, evolved gradually in relation to this cumulative ordering of trial and error experience. We may now call this "setting in order of experience',science, and see clearly how it promoted the development of the tool of technical advantage.

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 hand craft tools. They could be made and used by one man or 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 environ tools of our day, like the 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 history. They are comprehensive systems rather than local, and function most efficiently when organised in their largest universal patterns or networks. All of our other comprehensive tool network **systems,** like electrical power and communications grids, operate on the same principles. Their optimum efficiency networks may no longer be contained within national boundaries and the necessary development amortization has gradually gone outside the capacities of private enterprise, and begins to transcend any one national capacity to wholly operate and maintain2. The above gives some of the essential differences between craft and industrial tools.

When we speak generally about technical advantage we refer to the ability to convert energy into work. This channelling of natural forces into preferred use patterns is basically the organic life process - the energy conversion cycle. We absorb energy in one form and transform it for internal and external usage, Part goes towards maintaining the internal metabolics of the organism and part is available for inter-environment transactions; e.g., at the primitive level, the mobility necessary to seek out

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1. Physical Dissolution - 'is not ashes to ashes, dust to dust, but relative pattern abundance'. (see chart of relative abundances of elements in universe, earth and man)

2. The Tel-Star communications satellite is a recent dramatic example of such international cooperative trending.

more food or energy sources, physical work to extract energy, e.g., chopping wood, planting, harvesting corn, etc. The latter may be referred to as the mechanical energy we have available from our food/energy intake which has been calculated at an average 20% efficiency, i,e., from our 100% caloric intake we can put out a measurable 20% in physical work.

But in the case of man this overall physical efficiency rating in no way reflects his basic survival measure. Brain **power** is incalculable, and from the earliest times man has consciously created technical advantages which extended his own energy conversion capacity.

The throwing stick, lever and fulcrum and the hoe are amongst such early extensions. But for many centuries man relied greatly on his own muscle and that of the draught animals he trained to his use. His earliest physical and technical extensions were thus relatively low energy converters and sufficed only for immediate. or not too distant requirements.

The leisure, or re-investible time necessary for the further development of civilization could only be had when sufficient energy surpluses were available, which freed individuals from immediately essential work. Such surpluses cam from the rise of agriculture and irrigation and the evolution of technical advantages which gave better performance for human energy invested in their creation and operation. Agriculture was more 'efficient' than food gathering or hunting in rendering larger surpluses to store against future need, which in turn allowed more forward planning, for larger periods of man's activities. But the first high energy converters were the sailing ships. Turning wind energy into a preferred pattern use, these did not diminish the energy available to man as food. They could carry much more in one trip than many men or animals and they could run 24 hrs in the day.

With the sailing ship, whose origins have been set in the far East at dates earlier than any comparable Western vessels, man for the first time came to control large amounts of power which was independent of plant life and the numbers of people available to use it. The evolution of the great early sea empires, e.g., Crete,and their attendant high yield technologies has been obscured by local land histories and the secrecy practiced by the early maritime masters.

We have sketched out this picture of man's early environ relations as it's comments suffice for the thousands of years right up into the 19thCentury. In referring to the time scale of man on earth given in this introductory section, one might quote the eminent historian Arnold Toynbee, "All chronicled history is contemporary history1 ! "

The explosion of intellectual ferment and out pouring of ideas, inventions came very suddenly in our recent past. The fusion of Eastern and Western knowledge occurring in the Ancient World is almost simultaneous with the European renaissance in our bird's eye view, and both are attendant on the integrated complexity of advantage

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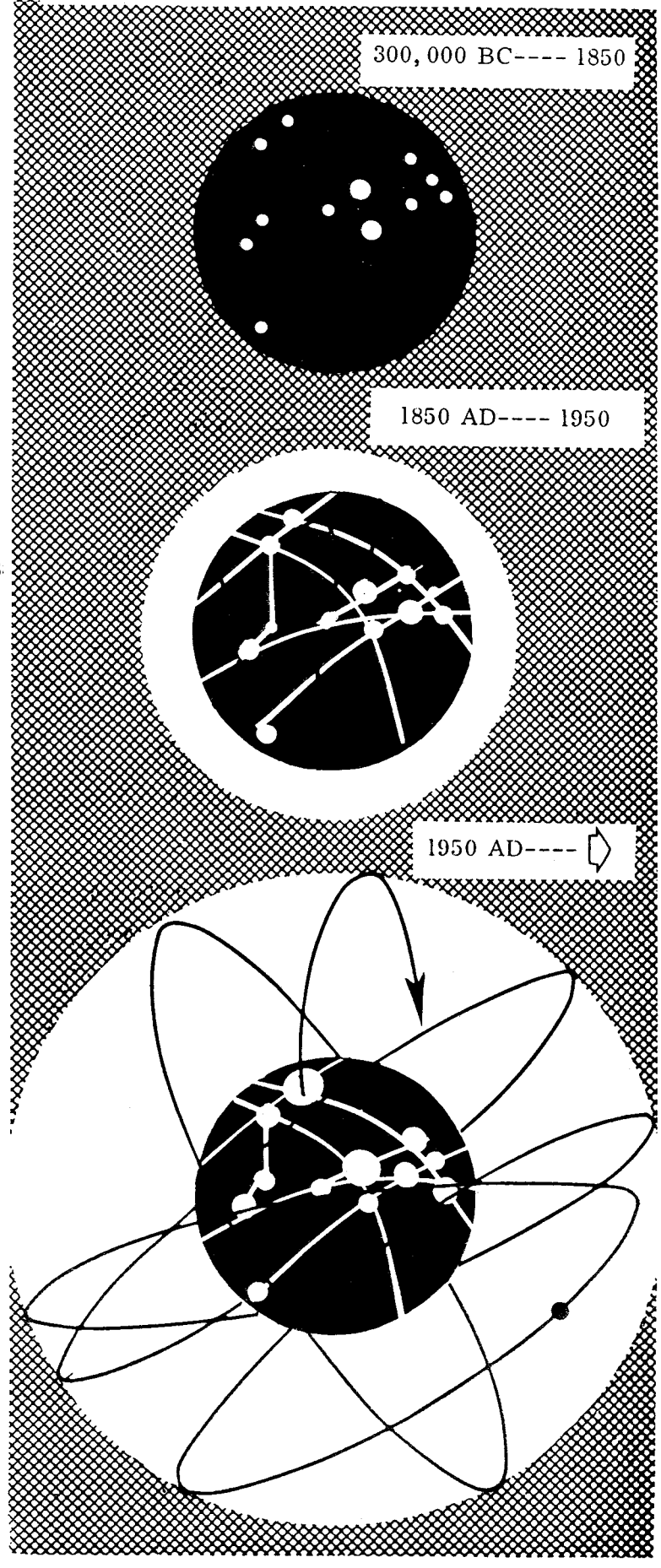
1. A. Toynbee - address to Washington University, St. Louis, MO., USA, June, 1963.

HISTORY OF MAN'S ECOLOGICAL SWEEP OUT



Picture one may be called, "The first half million years were the hardest." Ignorant and isolated, man was unaware of other men and of the potentials of friendship, integrated resources, and mutual survival. The first picture is of a microbespeckled, enormous sphere, an arithmetical isolation, a physical impasse, escapable only through intellect, instrumented -- through science.

Picture two shows man linking up resource and survival by lines of transport and communication. Wealth is generated astronomically. Standards go up. Health and life expectancy tend to double. But in 5000 years the velocity of integration and increased energy flow leads to an arterial cloggage and explosive high pressure. The two-dimensional picture is a neat linear equation, fulfilled--and again occurs an impasse escapable only by intellect.

Picture three shows the intellectual answer--a new volumetric and dynamic dimension--wireless, trackless, omnidirectional. It is a moving picture. Everywhere its physical facilities move with ever-increasing velocity and synchronized knowledge, allowing man to choose when and how and where he wishes to move. He specifically controls his own accelerations and decelerations.

Ref: The Dymaxion World of Buckminster Fuller, Robert W, Marks, Reinhold Publ. Corporation, N. Y., 1960.

which had slowly accummulated in the preceding millenia. The histories of the great sea and land empires may be traced out in relation to the mercantile quest for deposits of the earth's resources unevenly dispersed around the globe. Not only for the precious metals but for the equally important iron, copper and tin ores, for the dyes, spices, etc. The knowledge accummulated in all these various large scale journeys and transactions men began to be potently inventoried and tallied with the measurable behaviors of physical universe during the Renaissance.

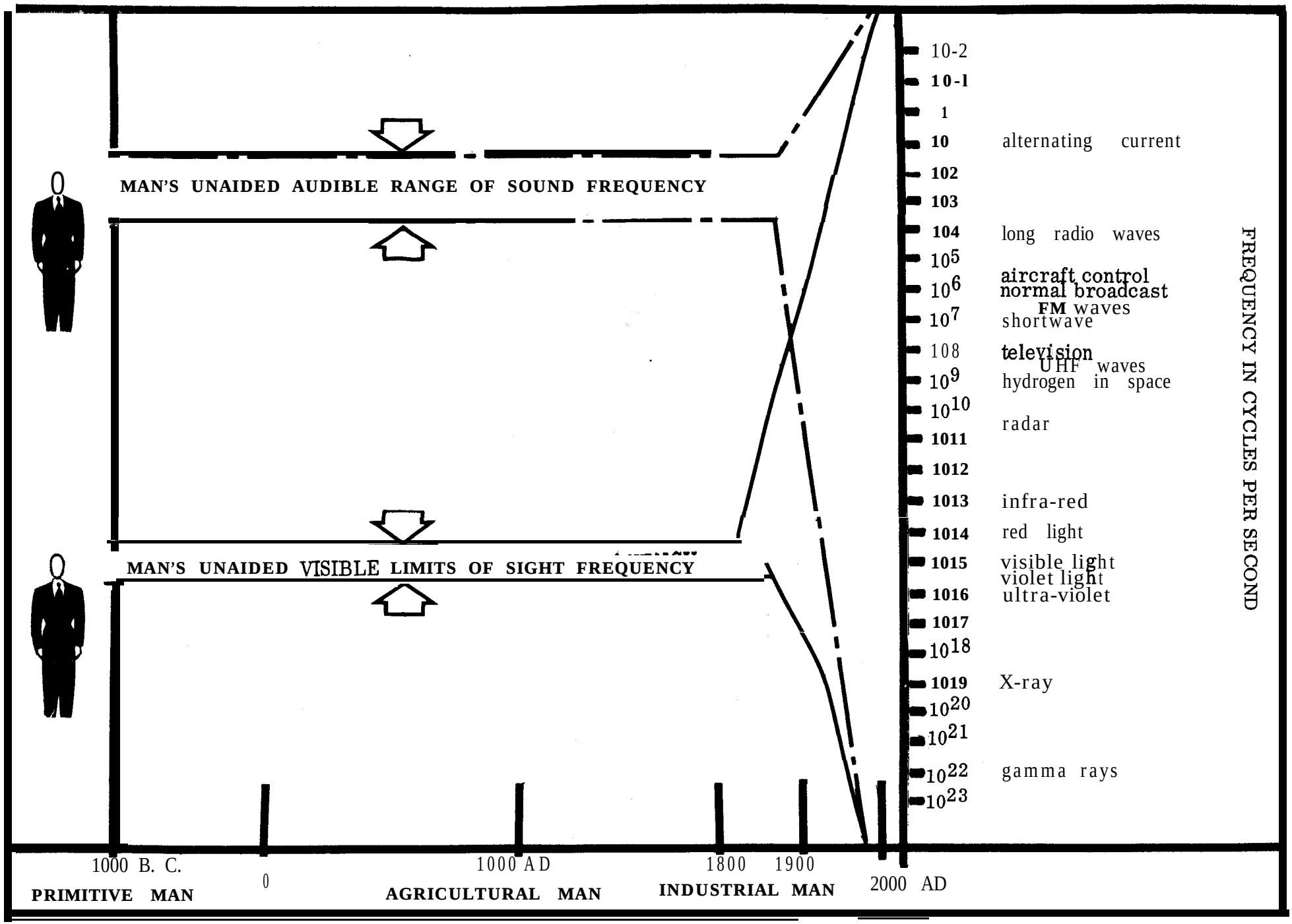
From this time on the major changes in our present world all have some common origin in the revolution in thought which began in Europe, in the 1600's - with the systematic derivations of scientific principles from direct observation and measurement of natural processes. **Both** the date and the discipline mark the end of one kind of culture of long established dominance, and the beginning of a new and quite unprecedented form. Since then, virtually every notion and cherished belief about the nature of the physical universe, of society and of man's place and function in it, which had gone to make up the older culture has been slowly eroded, modified and in some cases swept away.

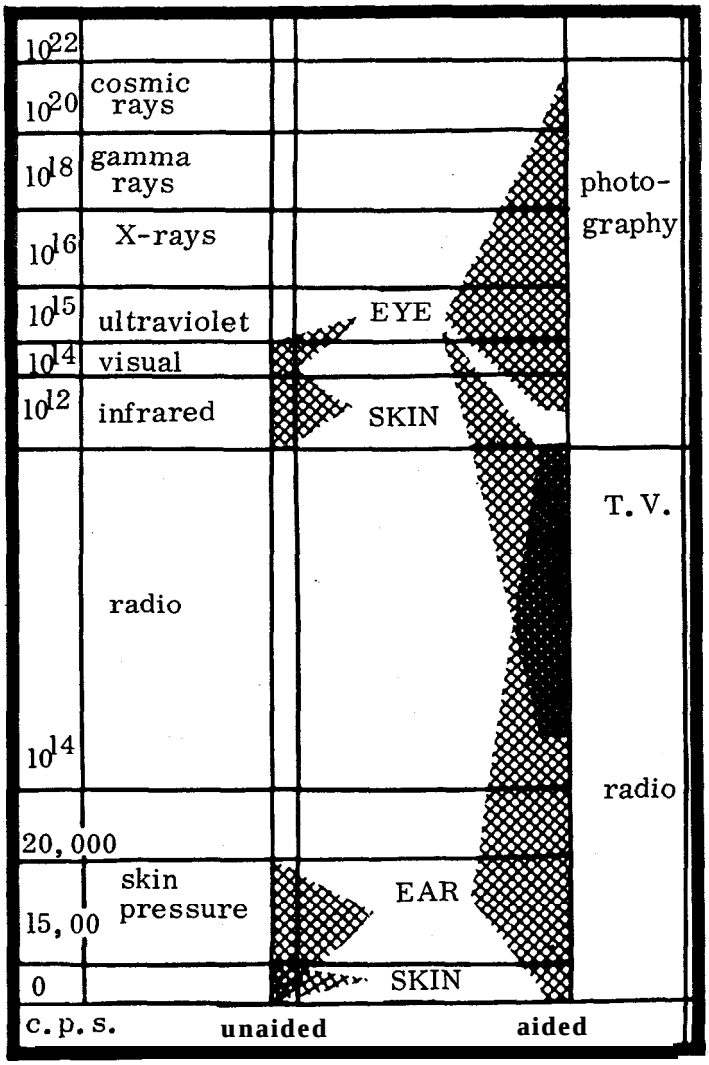
At first the material changes wrought in society by new discoveries in the sciences were relatively slow, but they gained rapid momentum, when such discoveries began to be fully applied to industrial technology, about one hundred years ago. The world we now live in, with its particular qualities of speed, mobility, mass production and consumption, rapidity of change and communication, is the latest phase of this development. It has no historical precedent as a cultural context. Man can now see further, move faster, produce more than ever before. Technical devices like the high speed camera, radio telescope, the jet and the rocket, etc., have extended the range of our sensory experience far beyond that ever dreamt of. Besides enormously enlarging the extent of the physical world available to our direct experience in an ordinary lifetime, such new tools provide us with what is virtually an extension of our environment. Through them we extend our psychic mobility. We can telescope time, move through history, span the world through visual and aural means in a variety of unprecedented ways .

The most abrupt and fundamentally important of the transitions which lead up to our present world developed in the sciences in the late 19c and became first evident in the technology of World War I. Experimental science began to extend its measurable range into the invisible subsensorial world of atomic, molecular and 'radiation' phenomena. This paced the acceler ated technology which began to deal in micro-tolerances in its new lathes and machine tools, and in the new invisible behaviors of high strength alloying.

We are still wrestling in much of our present day thinking with the difficulty of orienting towards this tremendous breakthrough into the knowledge of a world in which our major physical phenomena transactions are nonvisible and untouchable

"Better than 99 percent of modern technology occurs in the realm of physical phenomena that is sub or ultra to the range of human visibility, e. g., the dynamically operating functions of the transactions of information processing within the black boxes of visibly wired static circuitry, are entirely invisible. The invisible

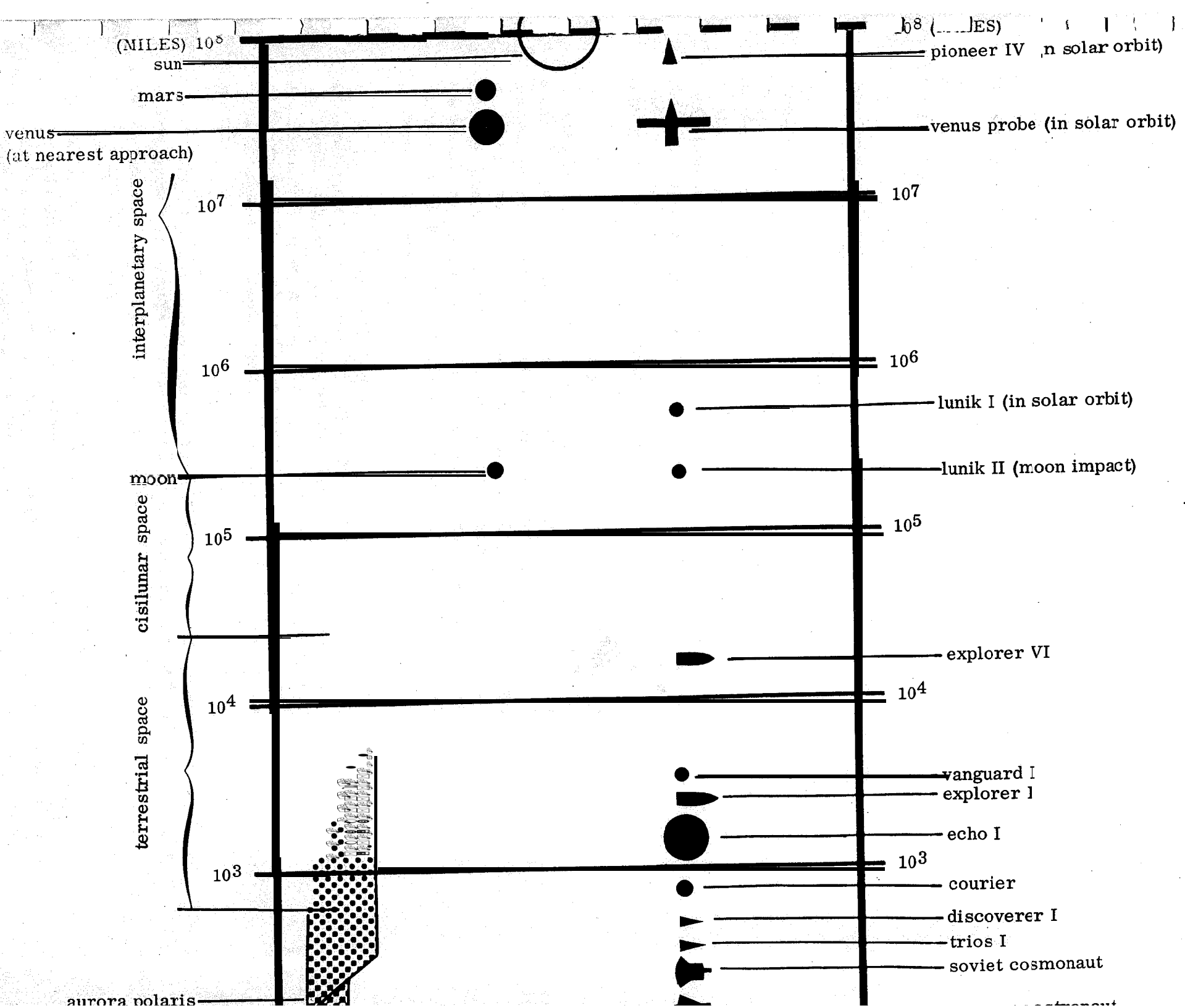

INCREASE OF KNOWLEDGE
ELECTROMAGNETIC SPECTRUM KNOWN
MAN'S UNAIDED AUDIBLE RANGE OF SOUND FREQUENCY
MAN'S UNAIDED VISIBLE LIMITS OF SIGHT FREQUENCY
10-2
10-1
1
10
102
103
104
10^5
10^6
10^7
108
10^9
10^10
1011
1012
1013
1014
1015
1016
1017
10^18
1019
10^20
10^21
10^22
10^23
alternating current
long radio waves
aircraft control
normal broadcast
FM waves
shortwave
television
UHF waves
hydrogen in space
radar
infra-red
red light
visible light
violet light
ultra-violet
X-ray
gamma rays
FREQUENCY IN CYCLES PER SECOND
1000 B. C.
0
1000 AD
1800
1900
2000 AD
PRIMITIVE MAN
AGRICULTURAL MAN
INDUSTRIAL MAN

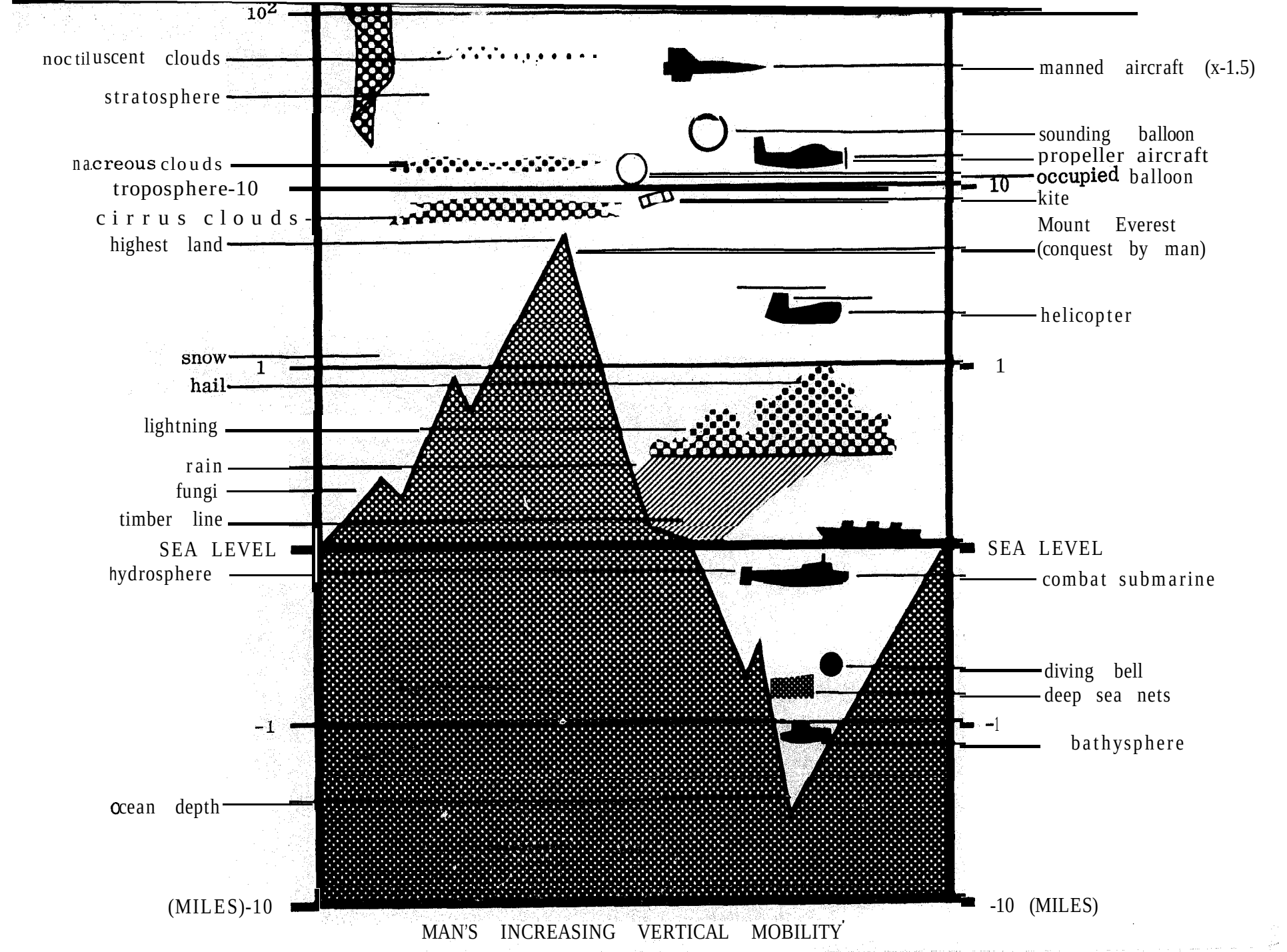


RELATIONSHIP OF MAN TO ELECTROMAGNETIC SPECTRUM

(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 electromagnetic 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.)


(MILES) 10^8
sun
mars
venus
(at nearest approach)
interplanetary space
10^7
10^6
moon
cisilunar space
10^5
terrestrial space
10^4
10^3
aurora polaris
10^8 (MILES)
pioneer IV (in solar orbit)
venus probe (in solar orbit)
10^7
10^6
lunik I (in solar orbit)
lunik II (moon impact)
10^5
explorer VI
10^4
vanguard I
explorer I
echo I
10^3
courier
discoverer I
trios I
soviet cosmonaut



MAN'S INCREASING VERTICAL MOBILITY

transactions sometimes result in visual transformation of our environment. We can see the telephone wires but not the conversations taking place therein. We can see the metal parts of airplanes or rockets gleaming in the sun, but there is nothing to tell us how relatively strong those metals are in comparison to other metals. Aluminum alloys as structural metals are commercially available which vary in strength so widely that some varieties are twice as strong, some four times as strong, and some eight times as strong as one class of aluminum. None of these varieties can be told from the other by the human senses, not even by scientists skilled in metallurgy, when unaided by instruments. The differences are invisible.

World society has throughout its millions of years on earth made its judgements upon visible, tangible, sensorially demonstrable criteria. We may safely say that the world is keeping its eye on the unimportant visible 1 percent of the historical transformation while missing the significance of the 99 percent of overall, unseen changes. Forms are inherently visible and forms no longer can "follow functions" because the significant functions are invisible. That era of essentially visible "modernism" is over. The architecture of superficial "functionalism" is meaningless and dead. What usually we speak of as our everyday world is a stage set with visible props which are easily manipulated by ignorant people to exploit the equal ignorance of others. The unreliable, uninformative and often deliberately misinformative scenery of that stage is soon to be radically altered due to the inexorable trendings in the sub or ultra visible alterations of man's relationship to universe.

The alterations are being made by scientists who are specialists, each preoccupied only with his special local evolutionary event. There are very few men today who are disciplined to comprehend the totally integrating significance of the 99 percent invisible activity which is coalescing to reshape our future. There are approximately no warnings being given to society regarding the great changes ahead. There is only the ominous general apprehension that man may be about to annihilate himself. To the few who are disciplined to deal with the invisibly integrating trends it is increasingly readable in the trends that man is about to become almost 100 percent successful as an occupant of **universe**[1].

This necessary reorientation of thought in terms of invisible but coherent universal patterns is particularly required in our 'resources' thinking. We have included in this section a chart of the relative abundances of the elements in universe, in man and in the crystalline, gaseous and liquid envelopes of the earth. In the pages which follow there is also a chronological table of the discovery, i. e., acquisition, by science of the 92 elements. Taken together these furnish an acute commentary on man's 'resource' position.

The elements are our fundamental inventory of the components with which the universe is constructed. They are not things but patterns, and are complimentary to one another like the gears of a watch - the gears of the universe.

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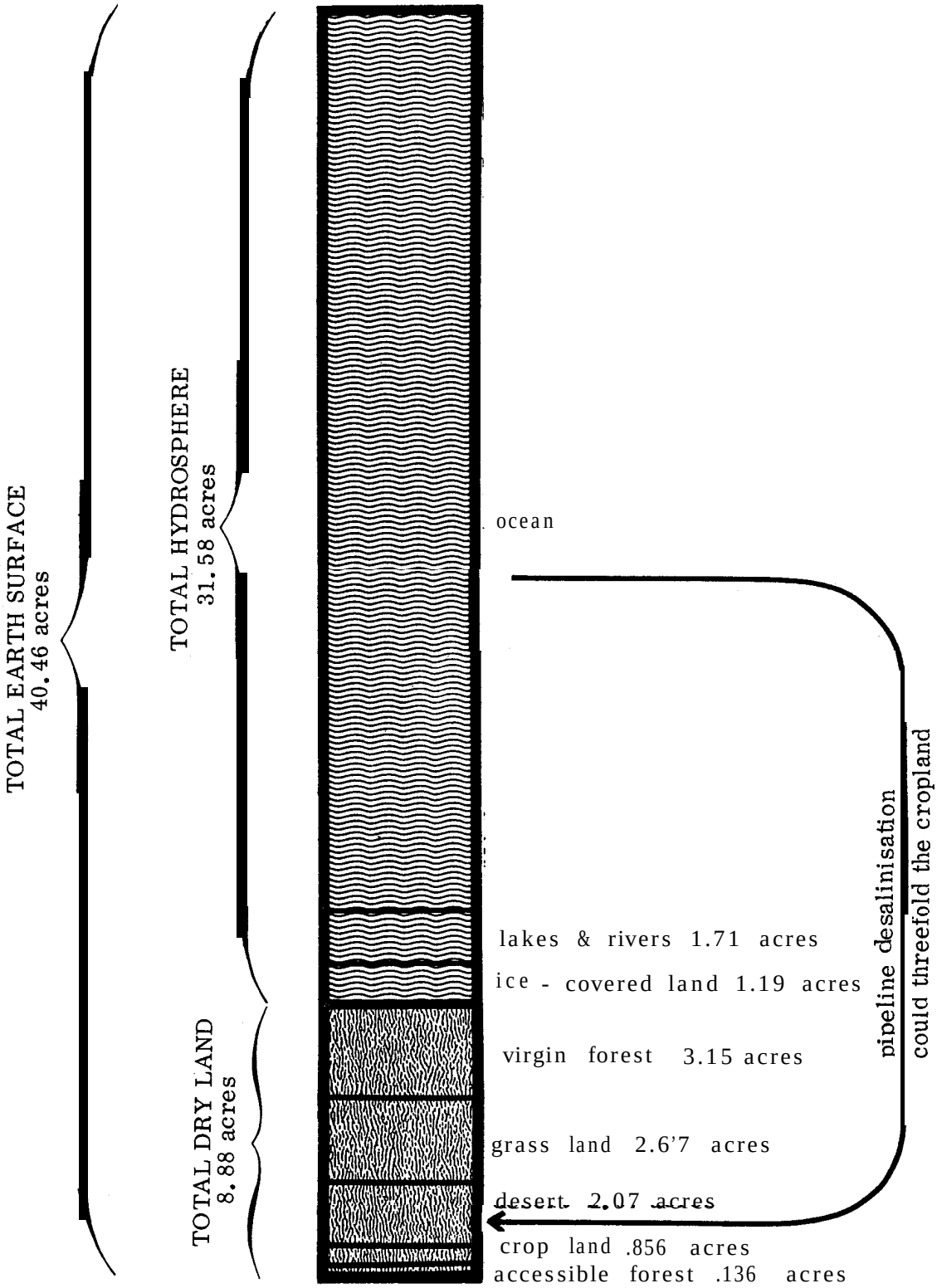
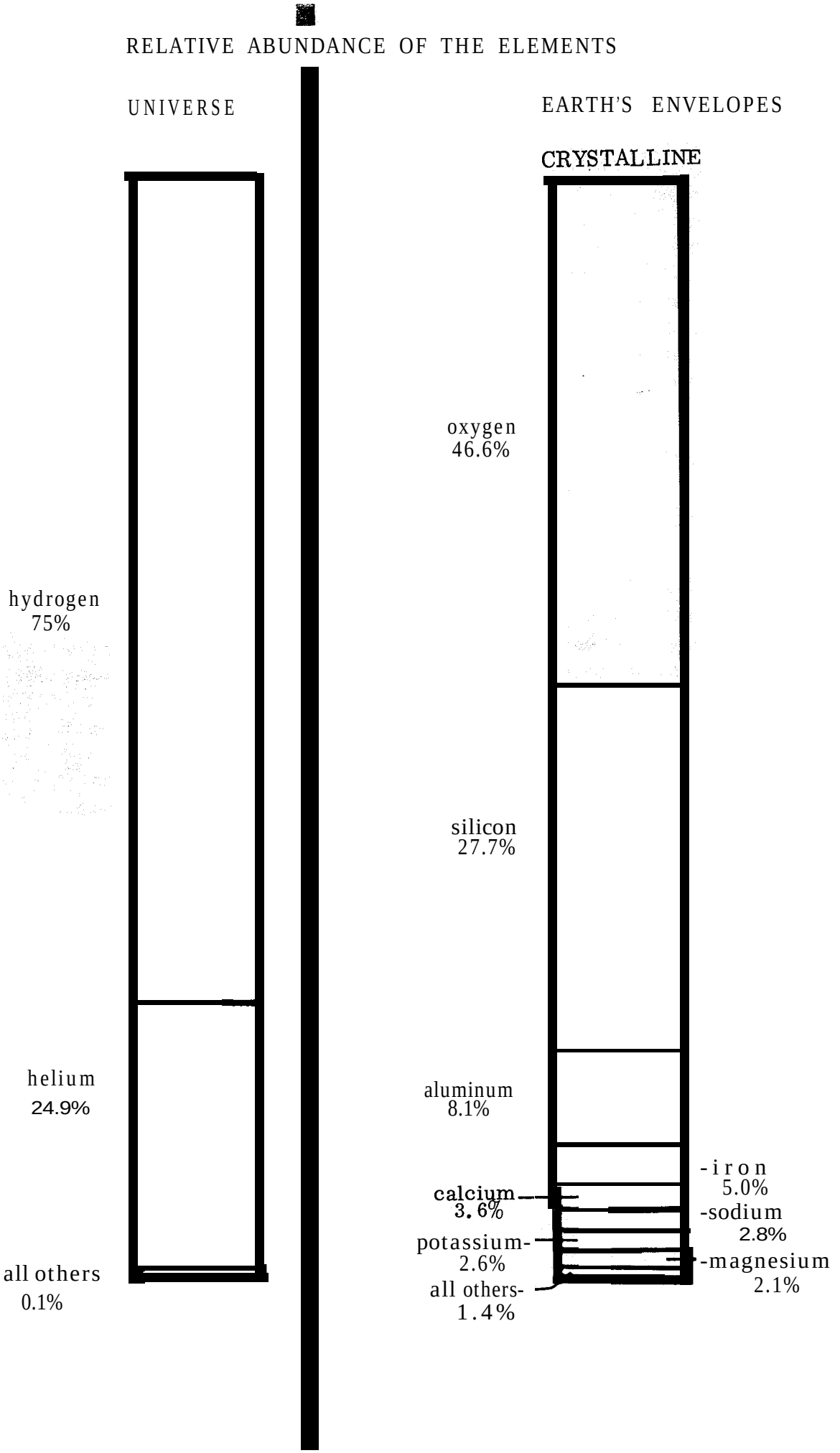
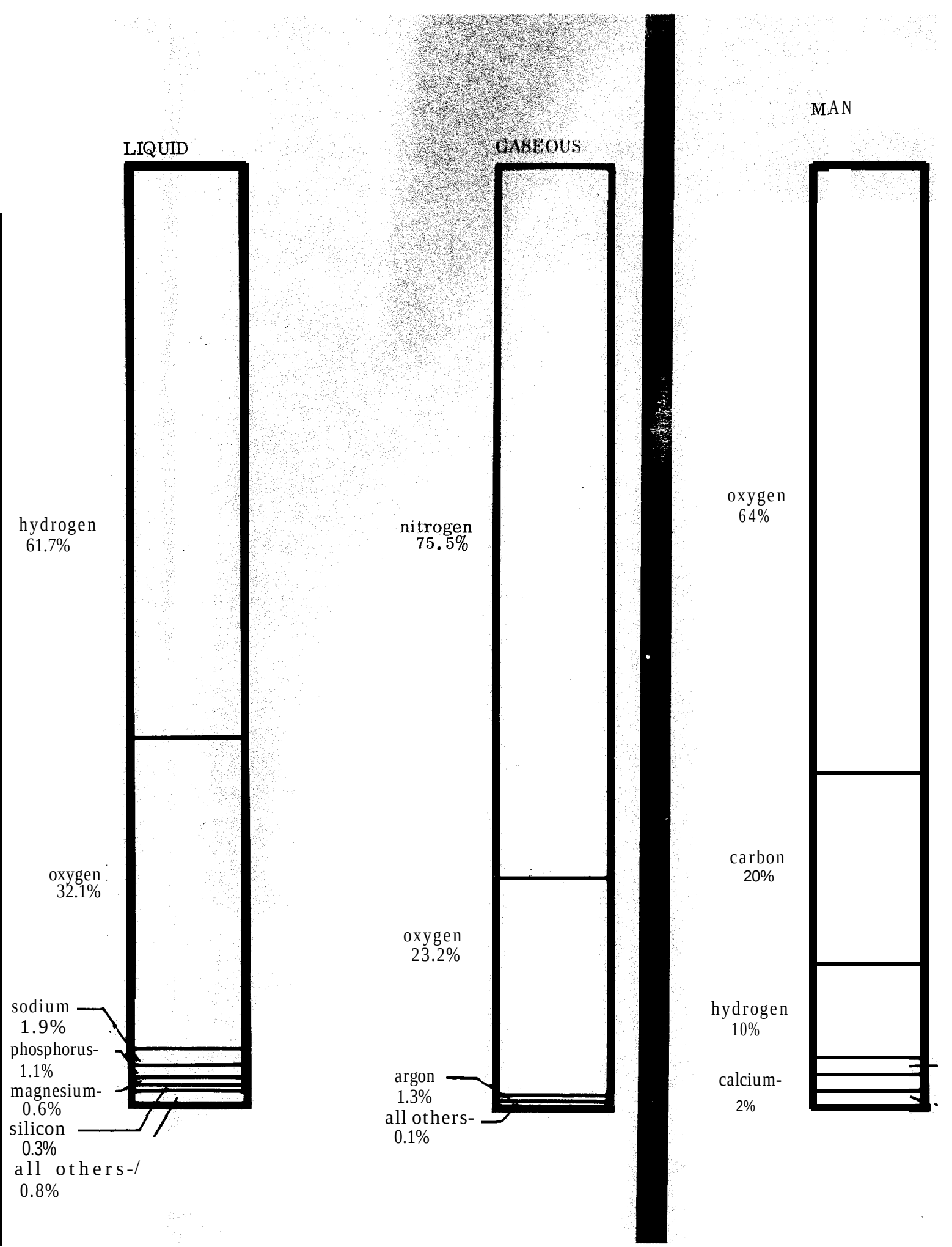
1. The actual readibility of our trending pattern of man's potential success may be seen in the combined diagrammatic breakdown in this section of man's increasing life expectancy over the years. Industrial man's gain in years of re-investible time is approximately equal to the total life expectancy of man in early primitive periods.

EARTH SURFACE PER CAPITA



RELATIVE ABUNDANCE OF THE ELEMENTS



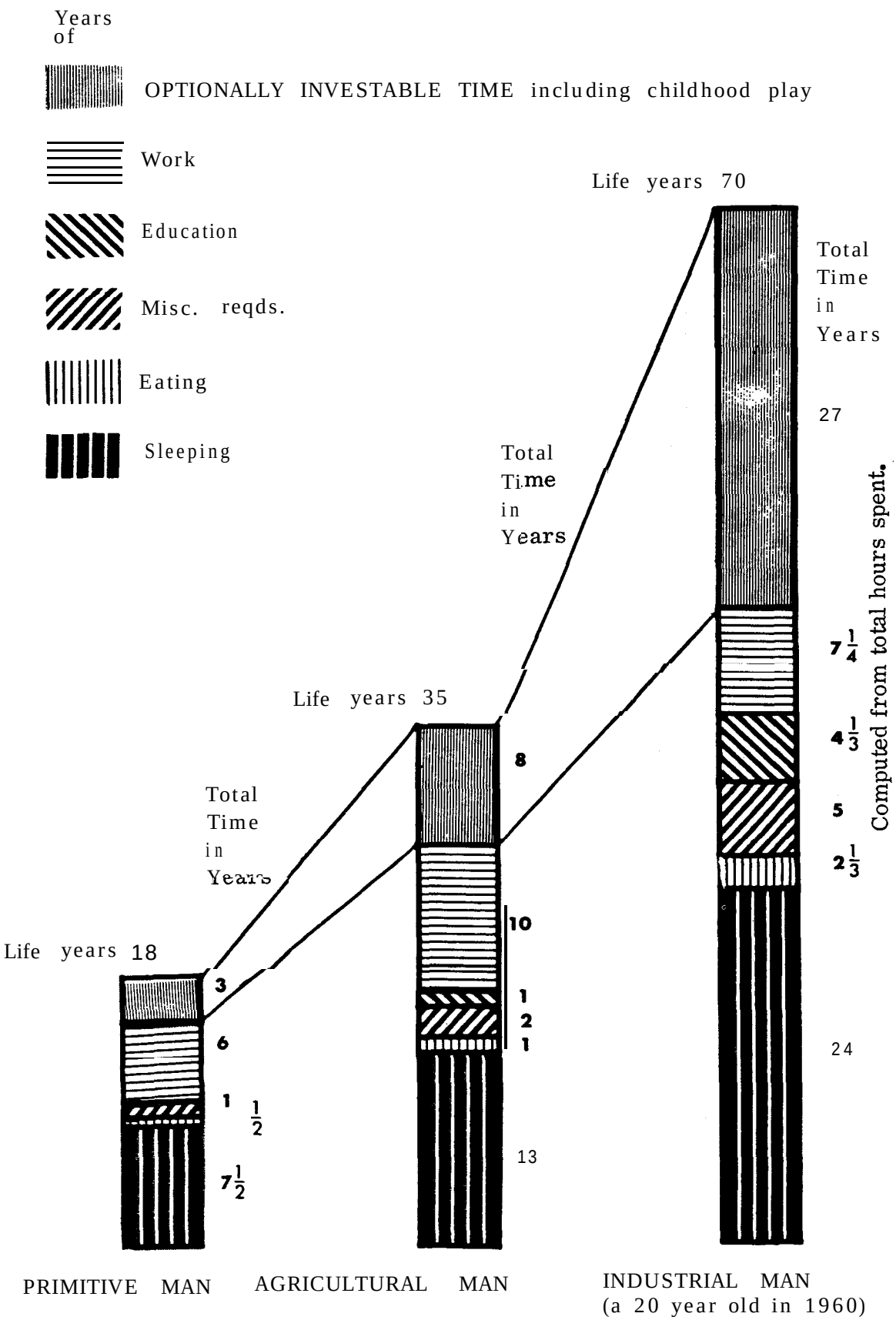

LIQUID
hydrogen
61.7%
oxygen
32.1%
sodium
1.9%
phosphorus-
1.1%
magnesium-
0.6%
silicon
0.3%
all others-/
0.8%
GASEOUS
nitrogen
75.5%
oxygen
23.2%
argon
1.3%
all others-
0.1%
MAN
oxygen
64%
carbon
20%
hydrogen
10%
calcium-
2%

This inventory then is our universal stockpile of re-associable components- but it is a stockpile which does not become 'used up',as the event patterns of which it is composed are simply associated for a particular purpose, have a use cycle in this purpose form and are then dis-associated into other preferred pattern uses. The complete table of the elements represents the net physical wealth of all men – and it is potentially inexhaustible when related to the maximising 'more for less' trending of the industrial process which progressively extracts increased performance per unit of invested 'material', or associated element pattern. The crystalline envelope of the earth represents our gross tonnage reserve and its largely made up of iron, aluminum and other minerals in varying proportions. The ocean envelope contains additional reserves, and recent deep sea 'mining' has begun to tap the huge potential of the ocean bed and its deposited modes of metallic ores.

To complete this picture of the overall inventory of realizable wealth we should note the breakthrough into 'molecular engineering'. Materials Research has gone far below the sensorially measurable surface qualities and, as'molecular science', may now 'design' materials to particular specification.

Design science therefore, in our terms, must operate in a truly scientific manner which is integrative of all the present capacities of this great wealth inventory. In the transformative range of chemistry, physics and biology and their associated disciplines and technologies, the terms, organic, inorganic and synthetic are as expendable as the time hallowed design slogans, 'form and function' and 'truth to materials'. Architects have long built their visible module structures with no regard for the more cohesive sub-visible module patterns in their materials. Design science must go beyond the visible standards of Stone Age architecture – to taking the stone apart and, for example, upping tensile strengths to many thousand fold gains in tensile coherence. The inventory and relative abundance of all the re-associable elements are the raw materials of a new world architectural design science.

TOTAL TIME SPENT IN VARIOUS ACTIVITIES BY
PRIMITIVE, AGRICULTURAL & INDUSTRIAL MAN.



INDUSTRIALIZATION

"The objective, exact synergetic re-integration into a comprehensive, common, regenerative advantage of man - of all the subjective, exactly differentiated energy behaviors discovered by all the individual explorations of all history's exact scientists".

In the brief historical review of man, attention was drawn to the way in which he has uniquely survived by his capacity to organize his experience of the local energy events of universe, and from this stored experience develop environmental tools for use in future contingencies. He survives by anticipatory planning. It was also indicated that the technical aids, or environment tools, evolved by early trial and error experience were inherently local cases, derived from local experience and limited access to the inequably distributed raw materials available in and around the earth. The evolution of these local tools into the fully industrialized comprehensive tools, now present in universal networks was differentiated out. As tool phenomena the latter are distinctly different from the early craft advantages. Industry requires cooperation - men working together on coordinated tool manipulations, producing work of a complex nature which could not be produced by any number of men working alone.

Industrialization at our present stage also implies the full availability of a developed science giving access to the inventory of all 92 elements necessary to the development of the requisite metallic alloys, and other materials, and the power sources required for their productive use and their assembly for such production. It is usually overlooked that the acceleration in technical progress does not simply amount to the fortuitous accretion of mechanical aids accruing to man's invention of machines, but forms part of the general evolutionary pattern, This pattern, for man, may from this time, be predicated not wholly on natural selection or biological mutation but on his full access to the accumulation of his universal experience as more obviously now modifying his forward progress.

It is also evident that in the evolution of industrialized advantages the tool function itself has changed. Regarding the industrial tool as merely an extension of the hand tool, in the sense that the former only produces more, and more easily, is a gross over-simplification. The industrial tool develops regeneratively in diverse ways and even the term mass production related to its use requires some qualification. There is an early division into specialized tools for the production of particular end products, and into generalized tools which may be used to produce more tools on end products according to requirement. The 'generalized' machine tools themselves seldom get into mass production as the number needed rarely warrants this. In early phase industry the 'complex unit' was produced in quantity by assembly from available standard components produced by specialized tools. In real mass production terms the largest complex unit produced is of the scale and performance of the automobile. (The critical minimal 'mass' production rate of such units is an important

factor, for example, in considering the industrialized dwelling as either 'assembled' or 'mass produced ' unit). Later industrial developments still favor assembly of large complex units but from tailored' components produced by generalized tools. With the introduction of automatic controls we may now combine automated general purpose machine tools with high production specialized tools, the whole operation comprehensively planned towards final assembly. In this latter phase, industrial plants become less specialized, and more flexibly adapted to changing production need without much expensive retooling. In relation to changes in technology itself, and expanding world need, this is a vital factor in planning the full utilization of industrial resources.

-But a more complete review of certain aspects of industrialization, as given in our beginning definition, is required at this point, The industrial process inevitably trends towards universalization. The elements , unevenly distributed around the earth, which are essential to the process as total physical resource inventory of unique behaviour advantages, do involve a world around 'materials assembly line. This requires a series of progressive extractions, separation outs and re-routings towards the various tool complex destinations. At the terminal point, having invested great energies and time in collection, separation and transportation, it is required that further refining be carried out, so that from the re-association of preferred performance characteristics the greatest amount of work/gain may be extracted. This process then is inherently biased towards higher and higher performance per lb. of material invested and circulating in the industrial network, and this ratio is constantly upped by attendant scientific and teclmological development.

Technology improves with every re-employment as gained experience is consolidated in increasingdegrees of precision behaviour and dimensional data higher tensile strengths of new allowing and the longer wear characteristics of components as extended by metal fatigue studies, provide gains in performance over initial investment 'of material and thus a net increment of common wealth.

Aspects of this regenerative gain may be simply demonstrated by reference to certain of the charts given in further sections of this report - efficiencies in combustions, in tensile strengths of alloys, miles per auto tire, etc.

We have included in this section a schematic flow diagram of one part of the regenerative industrial cycle - in metals. When people refer to 'resource depletion' it is precisely such aspects of the industrial process which are overlooked. We may note from this diagram that materials are only *temporarily' located in different forms for varying periods. One can easily imagine such a flow animated, so that we might be able to observe the successive phase transformations and re-association cycles of all the metals and minerals in our total inventory. Through this re-cycling, with no appreciable loss,it is again powerfully evident that our 'created' wealth, i.e., of the industrial processes re-generative capacity, is inexhaustible. 'Resource depletion* is an attitude carried over from earlier periods when locally sustained communities could actually view their visibly depleted fuel and food stocks, Its use as a criterion marks the cleavage between local and comprehensive thinking. One

Profile of the Industrial Revolution
(Elements Inventory Chronology)

250 A.D. 1270 1290 1310 1330 1350 1370 1390 1410 1430 1450 1470 1490 1510 1530 1550 1570 1590 1610 1630 1650 1670

SAILING SHIP

EARTH ORBIT IN MAN MADE ENVIRONMENT CONTROL: PRODUCT OF SUCCESSFUL APPLICATION OF HIGH PERFORMANCE PER UNIT OF INVESTED RESOURCES

PROFILE OF THE INDUSTRIAL REVOLUTION AS EXPOSED BY THE CHRONOLOGICAL RATE OF ACQUISITION OF THE BASIC INVENTORY OF COSMIC ABSOLUTES-THE 92 ELEMENTS

LEONARDO DA VINCI

COLUMBUS COPERNICUS

GALILEO

BOYLE

ALGORISMA INTRODUCES CYPHER INTO EUROPEAN CIVILIZATION FROM ARABS, THUS PROVIDING SCIENCE WITH PRACTICAL CALCULATING FACILITY

9 ELEMENTS WERE ACQUIRED BY CIVILIZATION PRIOR TO HISTORIC RECORD OF THE EVENTS, PROBABLY IN ASIA MILLENIUMS AGO

CARBON	#6 C
LEAD	'82 Pb
TIN	#50 Sn
MERCURY	#80 Hg
SILVER	#47 Ag
COPPER	#29 Cu
SULPHUR	#16 S
GOLD	#79 Au
IRON	#26 Fe

10 ARSENIC #33 As (First recorded discovery: Bavarian

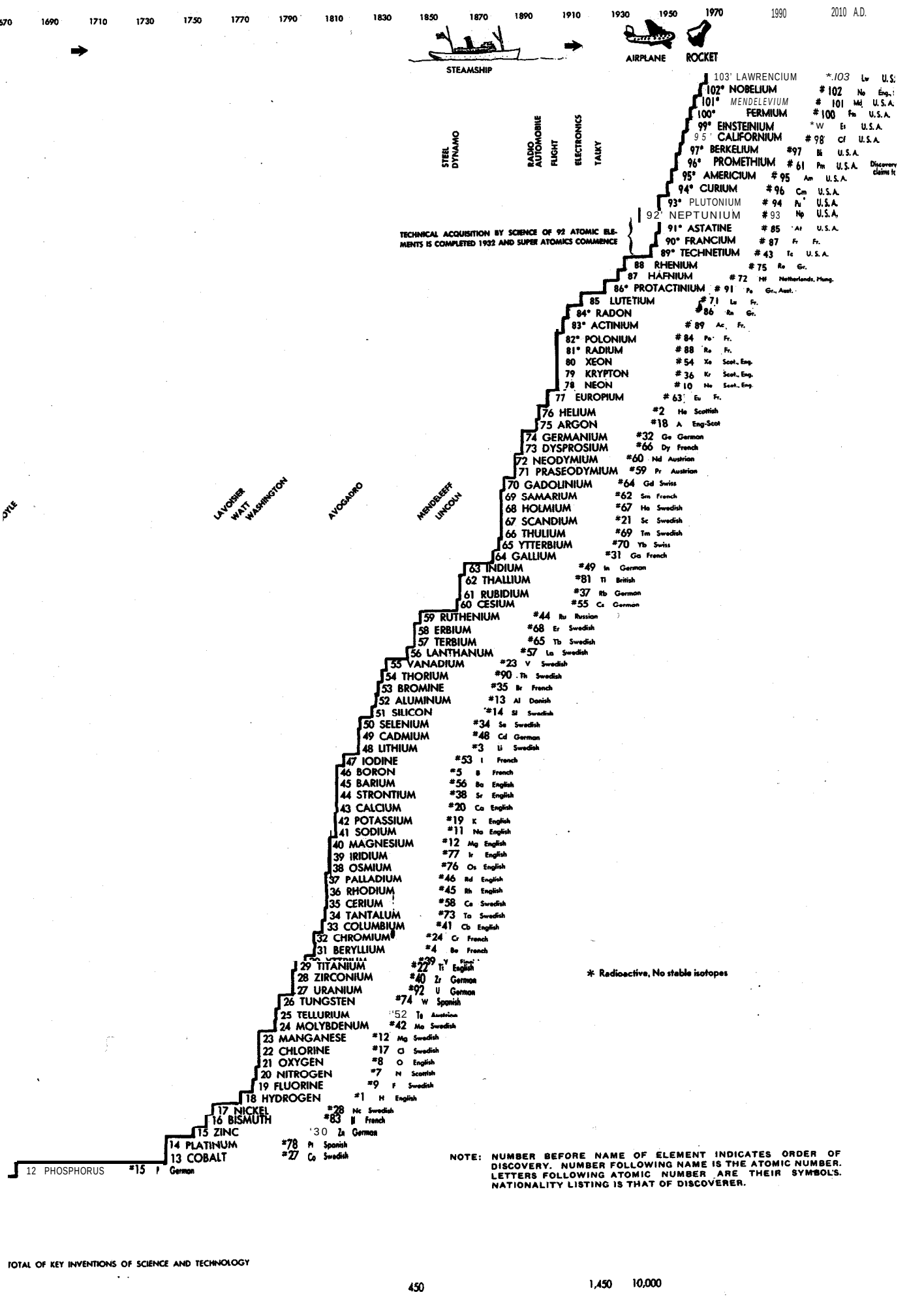
11 ANTIMONY #51 Sb German

12 P

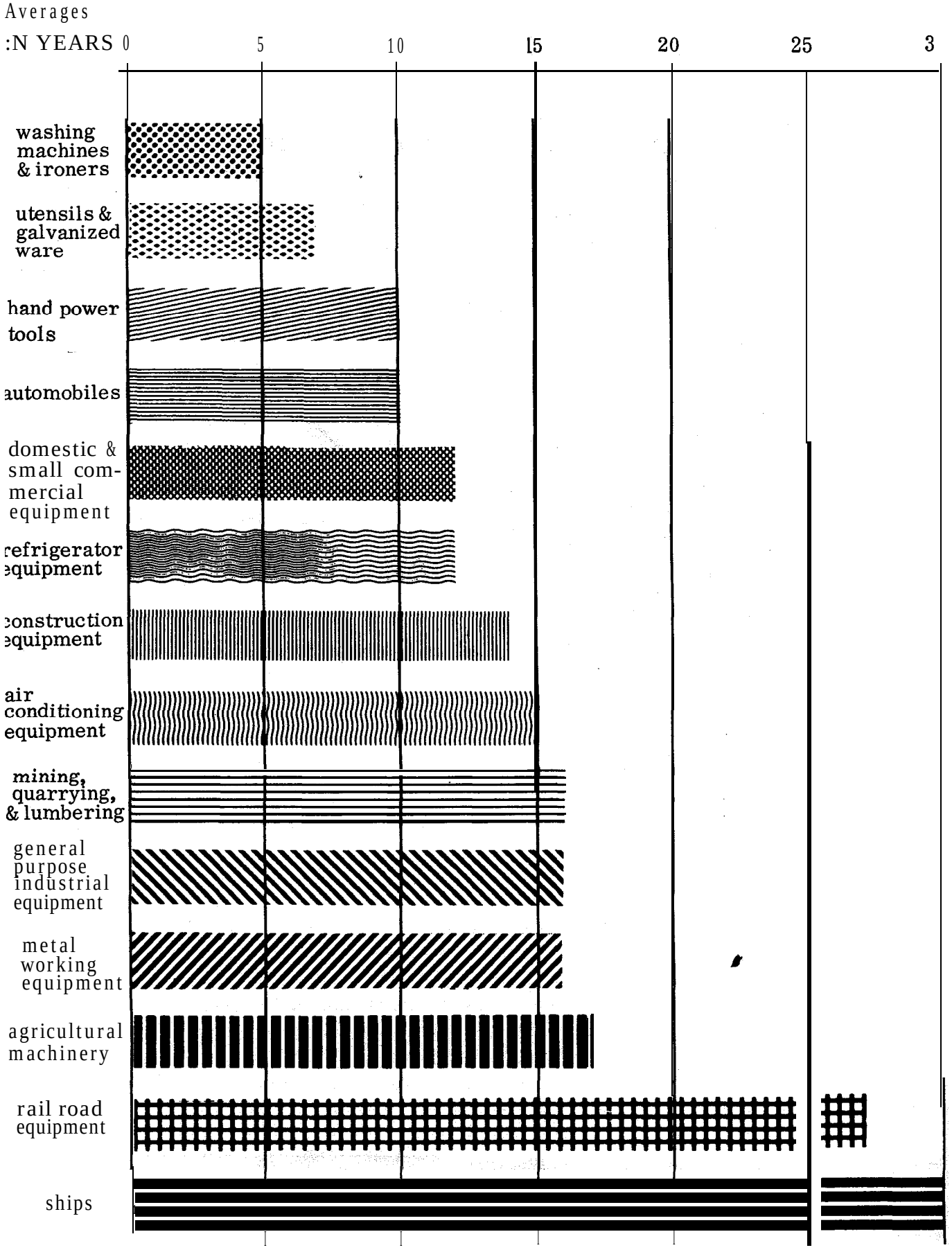
9
8
7
6
5
4
3
2
1

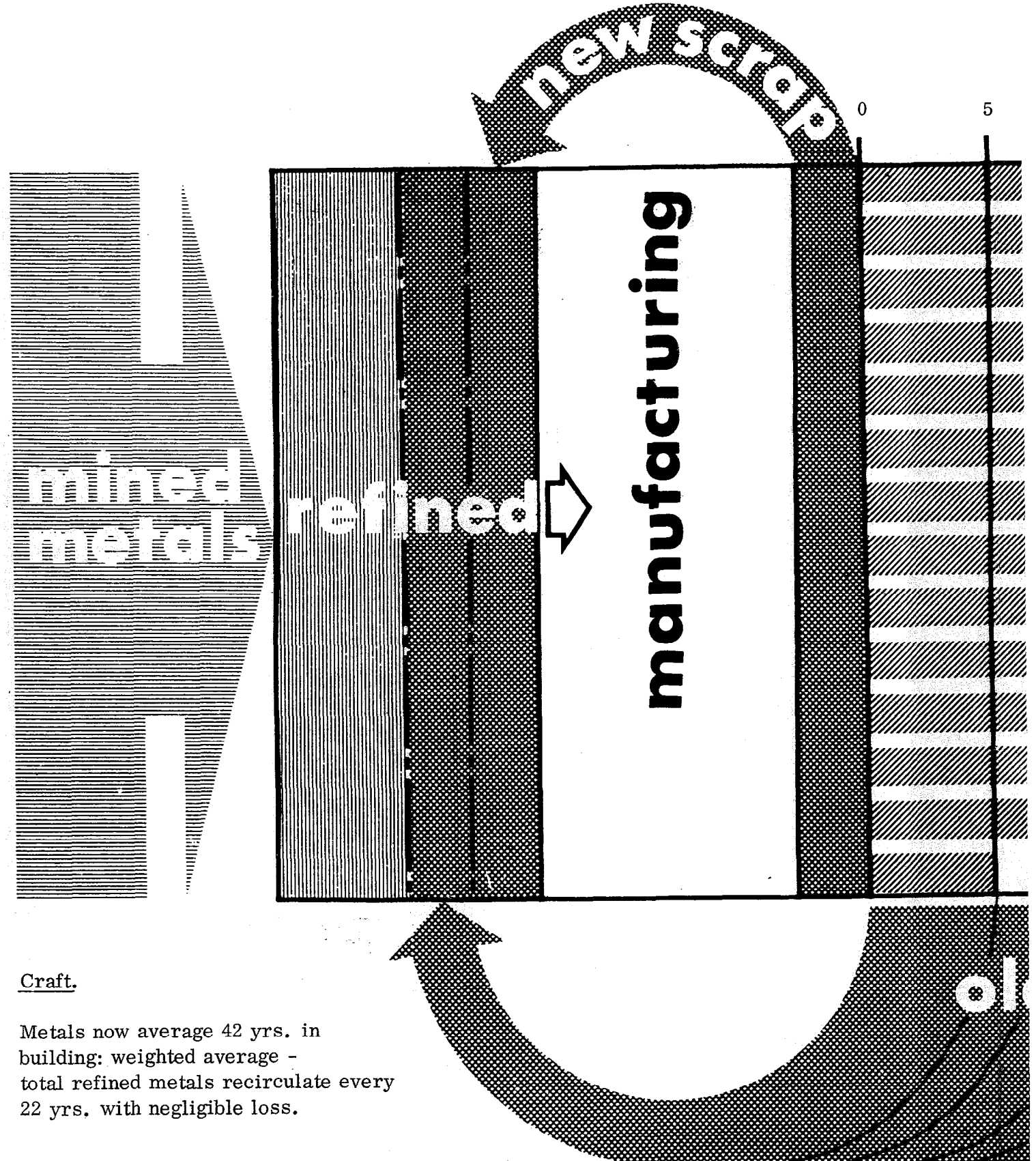
APPROXIMATE CUMULATIVE TOTAL OF

150


1670 1690 1710 1730 1750 1770 1790 1810 1830 1850 1870 1890 1910 1930 1950 1970 1990 2010 A.D.
STEAMSHIP
AIRPLANE
ROCKET
STEEL DYNAMO
RADIO AUTOMOBILE FLIGHT
ELECTRONICS
TALKY
LAVOISIER WATT WASHINGTON
AVOGADRO
MENDELEEFF LINCOLN
103' LAWRENCIUM *.103 Lw U.S.
102° NOBELIUM #102 No Eng.
101° MENDELEVIUM #101 Md U.S.A.
100° FERMIUM #100 Fm U.S.A.
99° EINSTEINIUM *W Es U.S.A.
95' CALIFORNIUM #98 Cf U.S.A.
97° BERKELIUM #97 Bk U.S.A.
96° PROMETHIUM #61 Pm U.S.A. Discovery claims fr
95° AMERICIUM #95 Am U.S.A.
94° CURIUM #96 Cm U.S.A.
93° PLUTONIUM #94 Pu U.S.A.
92' NEPTUNIUM #93 Np U.S.A.
91° ASTATINE #85 At U.S.A.
90° FRANCIUM #87 Fr Fr.
89° TECHNETIUM #43 Tc U.S.A.
TECHNICAL ACQUISITION BY SCIENCE OF 92 ATOMIC ELEMENTS IS COMPLETED 1932 AND SUPER ATOMICS COMMENCE
88 RHENIUM #75 Re Gr.
87 HAFNIUM #72 Hf Netherlands, Hung.
86° PROTACTINIUM #91 Pa Gr., Aust.
85 LUTETIUM #71 Lu Fr.
84° RADON #86 Rn Gr.
83° ACTINIUM #89 Ac Fr.
82° POLONIUM #84 Po Fr.
81° RADIUM #88 Ra Fr.
80 XEON #54 Xe Scot., Eng.
79 KRYPTON #36 Kr Scot., Eng.
78 NEON #10 Ne Scot., Eng.
77 EUROPIUM #63 Eu Fr.
76 HELIUM #2 He Scottish
75 ARGON #18 A Eng-Scot
74 GERMANIUM #32 Ge German
73 DYSPROSIUM #66 Dy French
72 NEODYMIUM #60 Nd Austrian
71 PRASEODYMIUM #59 Pr Austrian
70 GADOLINIUM #64 Gd Swiss
69 SAMARIUM #62 Sm French
68 HOLMIUM #67 Ho Swedish
67 SCANDIUM #21 Sc Swedish
66 THULIUM #69 Tm Swedish
65 YTTERBIUM #70 Yb Swiss
64 GALLIUM #31 Ga French
63 INDIUM #49 In German
62 THALLIUM #81 Tl British
61 RUBIDIUM #37 Rb German
60 CESIUM #55 Cs German
59 RUTHENIUM #44 Ru Russian
58 ERBIUM #68 Er Swedish
57 TERBIUM #65 Tb Swedish
56 LANTHANUM #57 La Swedish
55 VANADIUM #23 V Swedish
54 THORIUM #90 Th Swedish
53 BROMINE #35 Br French
52 ALUMINUM #13 Al Danish
51 SILICON #14 Si Swedish
50 SELENIUM #34 Se Swedish
49 CADMIUM #48 Cd German
48 LITHIUM #3 Li Swedish
47 IODINE #53 I French
46 BORON #5 B French
45 BARIUM #56 Ba English
44 STRONTIUM #38 Sr English
43 CALCIUM #20 Ca English
42 POTASSIUM #19 K English
41 SODIUM #11 Na English
40 MAGNESIUM #12 Mg English
39 IRIDIUM #77 Ir English
38 OSMIUM #76 Os English
37 PALLADIUM #46 Rd English
36 RHODIUM #45 Rh English
35 CERIUM #58 Ce Swedish
34 TANTALUM #73 Ta Swedish
33 COLUMBIUM #41 Cb English
32 CHROMIUM #24 Cr French
31 BERYLLIUM #4 Be French
29 TITANIUM #22 Ti English
28 ZIRCONIUM #40 Zr German
27 URANIUM #92 U German
26 TUNGSTEN #74 W Spanish
25 TELLURIUM #52 Te Austrian
24 MOLYBDENUM #42 Mo Swedish
23 MANGANESE #12 Mg Swedish
22 CHLORINE #17 Cl Swedish
21 OXYGEN #8 O English
20 NITROGEN #7 N Scottish
19 FLUORINE #9 F Swedish
18 HYDROGEN #1 H English
17 NICKEL #28 Nc Swedish
16 BISMUTH #83 Bi French
15 ZINC '30 Zn German
14 PLATINUM #78 Pt Spanish
13 COBALT #27 Co Swedish
12 PHOSPHORUS #15 P German
* Radioactive, No stable isotopes
NOTE: NUMBER BEFORE NAME OF ELEMENT INDICATES ORDER OF DISCOVERY. NUMBER FOLLOWING NAME IS THE ATOMIC NUMBER. LETTERS FOLLOWING ATOMIC NUMBER ARE THEIR SYMBOL'S. NATIONALITY LISTING IS THAT OF DISCOVERER.
TOTAL OF KEY INVENTIONS OF SCIENCE AND TECHNOLOGY
450
1,450
10,000

PRIMARY USEFUL LIFE OF PRODUCTS

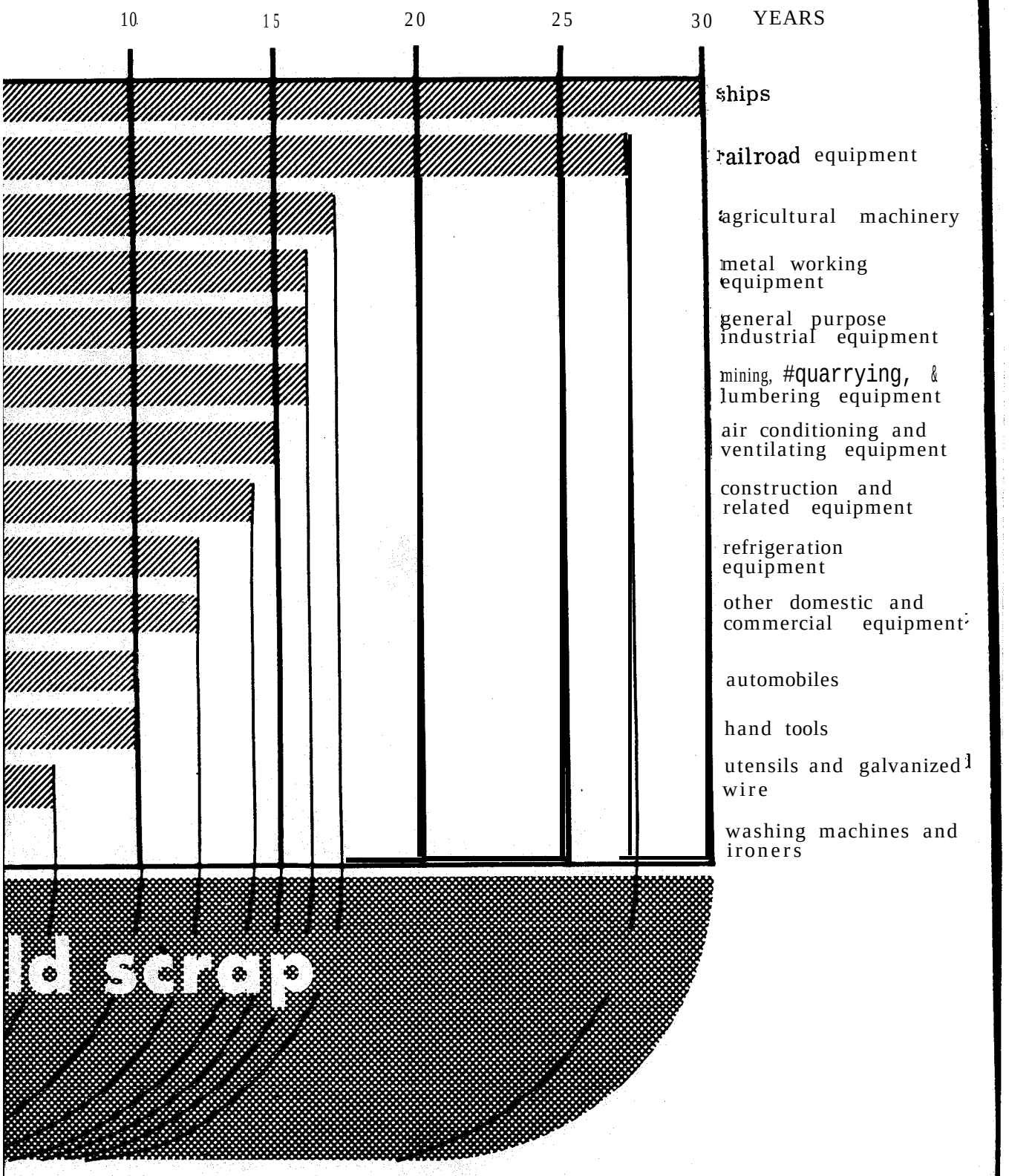




Craft.

Metals now average 42 yrs. in building: weighted average - total refined metals recirculate every 22 yrs. with negligible loss.

INDUSTRIAL REGENERATIVE CYCLE: METALS

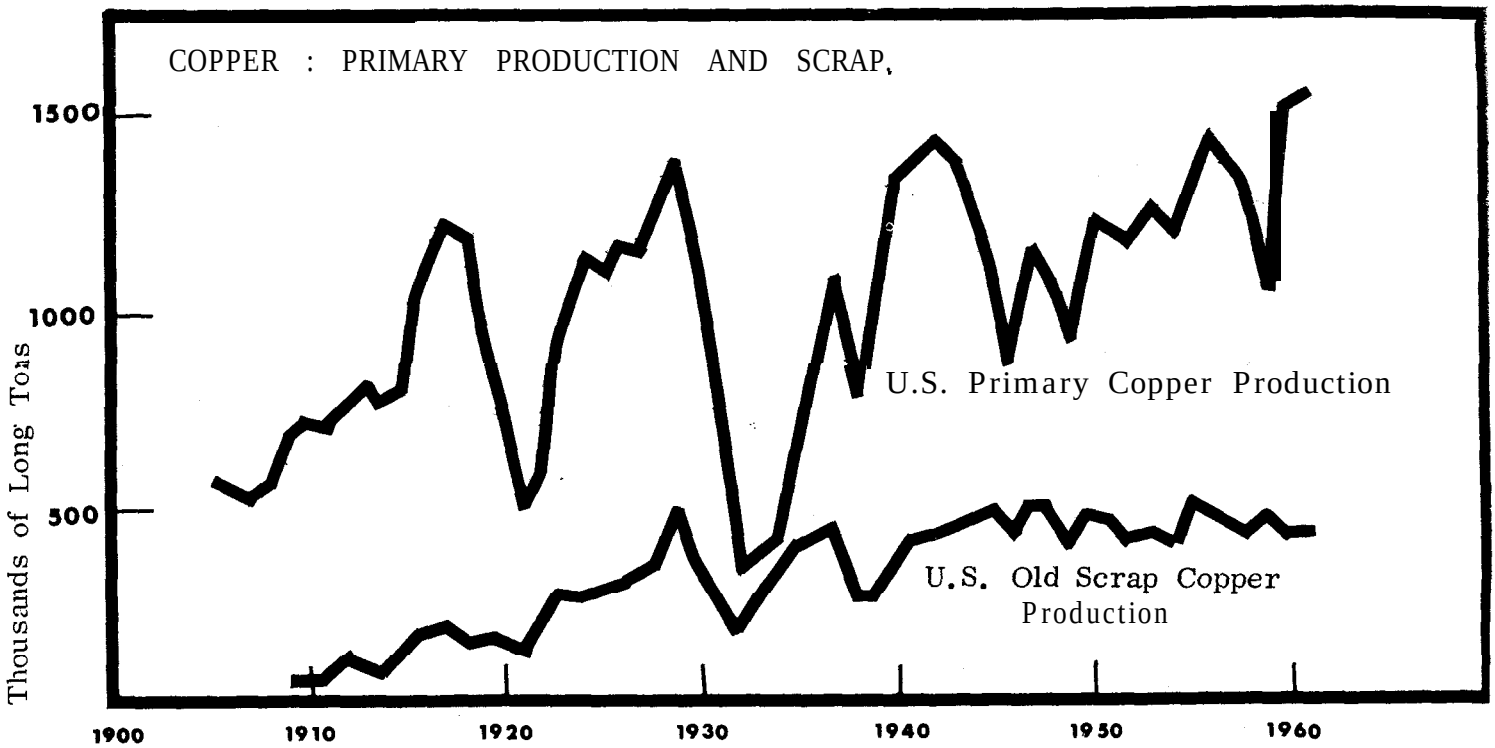


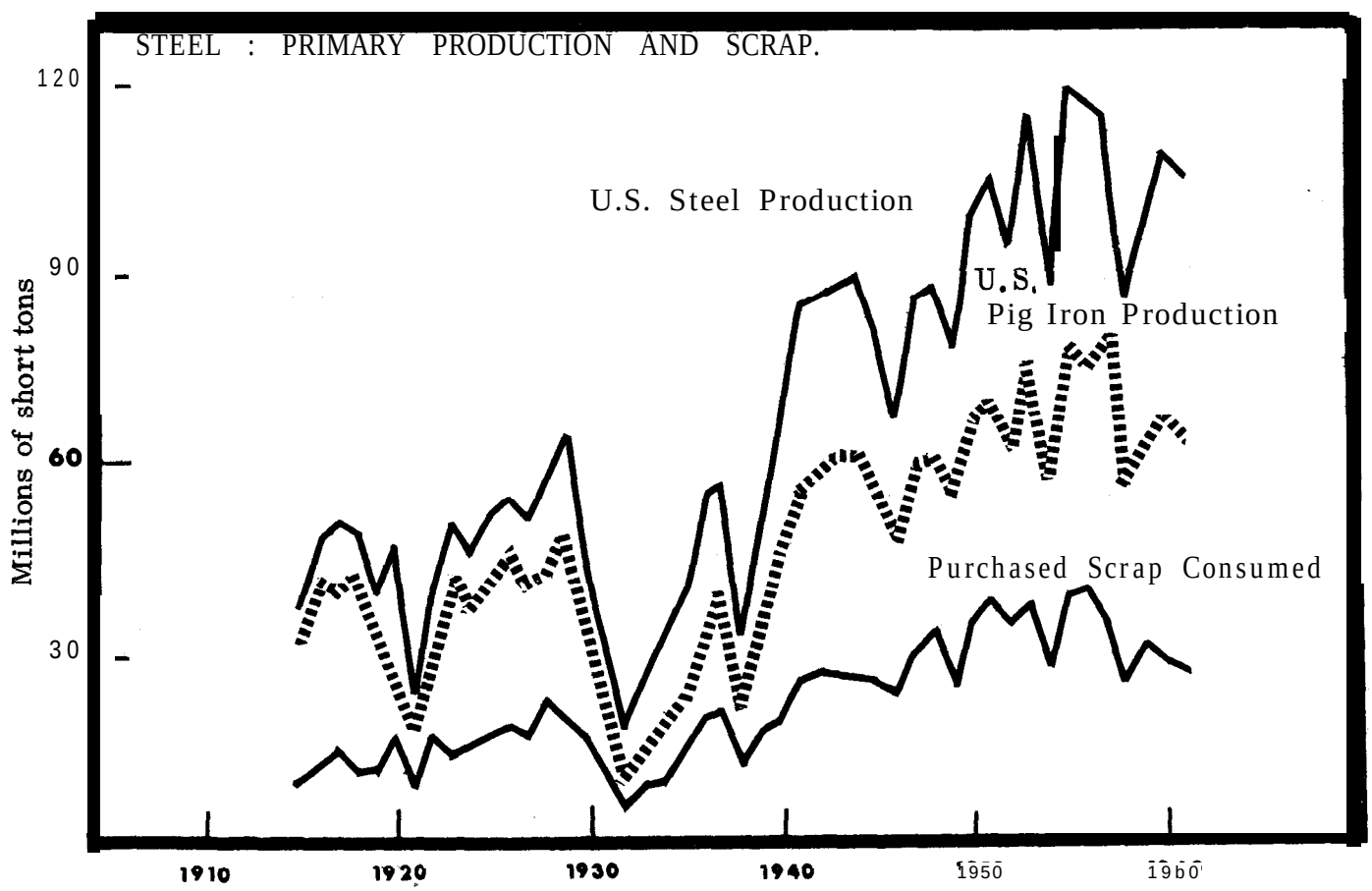
may refer later in discussing energy resources to the desirability of using 'income' rather than 'capital' sources and differentiate out between wind, water, solar and other re-cycling energy sources as 'income', against 'capital' fossil fuels like coal and oil. But this difference is not in terms of an either/or depletion but of relatively preferred efficiency gain.

It is important to realize also that the progressive separation, transportation and re-association earlier referred to profoundly alters our physical world relation and major geophysical patterns. Materials extracted return to their natural source, only, in vastly re-associated forms. Above surface mines of refined materials displace and alter the basic resource pattern. The point has often been made that the major world body of tin reserve, i.e., the largest inventory of available tin, approximately equal to major below ground reserves elsewhere, is in the U.S. From an original state of having little tin ore of workable quality this country now has the largest tin mine in the world above ground.

Another facet of the manner in which the industrial equation fundamentally alters our environ relations lies in its, gradual differentiation out of the human and machine functions and its progressive development of machines which off-load routine human work. Industrialization has from its beginning evolution trended towards automation, i. e., towards the elimination of man as a physical (muscle and reflex) machine. Early thoughts, of man chained to the machine and exploited by its owners, were obviously erroneous. The real trend is towards the elimination of man altogether as a mechanical worker and the replacement of his role by that of a re-generative consumer - 'The meek shall inherit the earth is simply mass production and consumption."

We have noted that the industrial equation works, most efficiently as a world wide operation. To maintain this efficiency and its rising ratio of re-generative performance characteristics, 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 the ranks of scientific and industrial research which develops the next wave of evolutionary industrial transformations. Men are unwittingly accelerating their capability to render the world's resource inventory adequate to the advancing needs of all men. That 'local' thinking persists in relation to the dis-employed, as <u>un-employable</u>, is simply failure to realize the re-generative wealth capacity of the whole process. Un-employed time is re-investible time - again re-generative - in education in expanding the parameters of living, in the possibility of fresh discovery and invention of further human advantage. To speak of how to pay people -(to return to school, to experiment - study and to create) - is an obvious anachronism, and mental block, in the face of our industrial wealth, -- a failure to understand the true nature of the industrial process. With todays impounding of total resources through the progressive re-cycling and re-conversion of inventory materials, 'science has hooked up the everyday plumbing to the cosmic reservoir'.


COPPER : PRIMARY PRODUCTION AND SCRAP.
Thousands of Long Tons
1500
1000
500
U.S. Primary Copper Production
U.S. Old Scrap Copper Production
1900
1910
1920
1930
1940
1950
1960


STEEL : PRIMARY PRODUCTION AND SCRAP.
Millions of short tons
120
90
60
30
U.S. Steel Production
U.S. Pig Iron Production
Purchased Scrap Consumed
1910
1920
1930
1940
1950
1960

WORLD ENERGY

Man's progress has been paced by his increasing ability to control and shunt natural energies into preferred forms of use. His own role as a 'mechanical' energy converter has become obsolete in the past hundred years, and he has come to function mainly as a controller and designer of high energy conversion patterns.

The earth surface receives energy from three main inputs - one, radiant solar energy: two, the kinetic and-potential energy of the earth in the gravitational system: three, geothermal energy from the earth interior. Other energy sources are sub-cycles of these, e. g. , the fossil fuels are stored solar energy deposits, water power taps the local hydrological cycles and wind power the atmospheric circulations. The fossil fuels are 'capital' energy and exhaustible, the other two examples are 'income' energies, regenerative cycles.

Energy consumed in the industrial process since its inception has been largely based on coal, oil, gas, and electricity generated from water power. There has been a phenomenal growth in high energy conversion ratios of output to input in the use of these fuels in the.past fifty years.[1] About 80% of all such energy is consumed within the industrially advanced countries and only about 20% in less developed areas. It is this type of energy consumption which particularly distinguishes high living standard areas in the world from those still limited to low grade energy converters of the biological type, i.e., human and draught animal energies extractive of plant and crop energy yields through craft tools of various types.

This sharp division will be particularly evident with reference to the energy slave map and table included in this section. As the 'have and have not' proportion within this map shows, the prime problem of world energy resources is to even out the present inequalities in industrial energy distribution – in effect to design ways of including within the fully developed industrial network those world areas which are on the *have not' side of the scale. This is a problem which can only be solved by competent design science ingenuity. The degree of its complexity is immediately evident but analysis of the charts of various increases of production and consumption over longer periods and in particular those which show cross trendings will give major indication of the prior ways in which this may be done. It is also evident that such 'have not' areas will not simply repeat the historical development of those already industrialized, but may immediately take off higher on the technological scale - with a faster acceleration of development adoption than the 'older' area. They have no great

---

1. In the generation of electricity, for example, the amount of fuel necessary for the production of one kilowatt-hour declined from 6.85 lbs. of coal or coal-equivalent in 1900, to 3.0 lbs. in 1920 and to 0.95 lbs. in 1955. This, in effect, represents an increase in thermal efficiency greater than sevenfold in only 55 years.

backlog investments of tools, factories and other industrial network systems to retard their integration of the latest scientific and technical advance and, indeed, will find themselves capable of installing systems far in advance of those already in operation in the present highly industrialized areas.

It may be noted also from inspection of energy slave distribution charting that the cycling of present world tensions relates directly to its inequable distribution frequency. Another potent indicator of the necessity for 'new forming', comprehensive scientific design strategy as again&he ineffectuality of reforming strategies !

In discussing such possible upping of living standards in global terms, most persons will refer to the depletable nature of energy resources now sustaining our present high standard industrial nations. As previously mentioned these operate largely on 'capital' rather than 'income' resources – on the finite reserves of fossil fuels rather than on the relatively in-finite and direct tapping of the great universal energy cycles of solar, tidal and waterpower energies. Redirection to use of recycling 'income' may then be the second stage priority in the world energy picture. It will phase in with the more urgent redistribution of industrialization.

The prospect of future energy resources do, in the main, belie most local resource estimates. Much work is already in hand, and great progress made in the use of solar power converters. Tidal power is already harnessed in various parts of the world and rivalled by other potential inland water powers as yet undeveloped. Electric power generation development from geothermal heat has been under way for some time in various areas. Nuclear power plant development has already widened its scope in terms of multinational cooperative exploration and use, e.g., 'Euratom'. It will possibly soon become one of our main energy transformations. Relative to this development is, of course, the now largely latent capacities of the oceans for providing enormous fuel sources. Controlled thermonuclear reactors using deuterium or heavy hydrogen as their main source of transformative material have been under experiment since 1945. One part of this hydrogen isotope is available in every six thousand parts of sea water. On the scale of ocean volumes present it has been estimated, that "there is enough deuterium in the sea to generate a thousand times more energy for the next million years than is generated in the world today".[1] The above comments by no means exhausts the list of possibilities in the present extending range of technical developments in energy conversion advantages. Certain of the most recent technical advances such as the fuel cell, afford more ' mobility' as energy converters and higher energy conversion efficiency, 80% in this case, than many of our present 'engines'.

The picture therefore of world energy resources is simply another facet of our total element inventory transformations. It is one of potentially inexhaustible sources which require only the sustained and accelerated application of scientific design competence for their full availability to all men. The cooperative powers necessary for their fully successful phasing in to our universal use require the prior industrial accrediting of all the have not millions still outside of the world industrial network. We need their upped living so that they may in turn contribute to the fullest developments of all mens' necessary advantage.

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1. Lewis L. Strauss, former chairman of the U.S. Atomic Energy Commission - quoted in "Conquest of the Sea," by C. Troebst.

Map Areas	Population			% of World Population			E
	1940	1950	1960				1940
Asia	1,212,000,000	1,389,000,000	1,679,000,000	54	55	56	2,565,000,000
Europe	573,000,000	576,000,000	641,000,000	25	23	21.4	6,720,000,000
Africa & Medit. Wld.	172,000,000	209,000,000	254,000,000	8	8	8.5	523,000,000
North America	146,000,000	168,000,000	199,000,000	6	7	6.4	9,350,000,000
South America	90,000,000	112,000,000	140,000,000	4	4	2.2	512,000,000
Central America	41,000,000	51,000,000	66,000,000	2	2	4.7	312,000,000
All Others	11,300,000	13,000,000	16,500,000	1.	1	.5	466,000,000
World	2,246,000,000	2,518,000,000	2,995,000,000	100%	100%	100.0%	40,448,000,000

Use of World Energy Map

An "energy slave" is determined as follows: In addition to the energy spent from his metabolic income in "working" his own body, one man in one 8 hour day can do approximately 150,000 foot pounds of work. A foot pound of work equals the amount of energy required to lift one pound one foot vertically. 'this additional work might be called net advantage-in dealing with environment. The "net advantage" potentially to be gained by each human each year, working 8 hours each of 250 days per year, is 37 1/2 million foot pounds.

Stated with a probable error of less than 10%, the world comsumption of energy from minerals fuels (coal, oil, gas) and water power for the year (1960) is 94.4 quintillion (94,429,000,000,000,000,000) foot pounds. Assuming man's efficiency in converting his gross energy consumption into work to average an overall 4% he will net ther (3,769,960,000,000,000,000) foot pound

Dividing this figure by 37 1/2 millio man's net annual energy advantage), we 100.6 billion man year equivalents of wo him. The 100.6 billion man equivalents billion energy slaves. 100.6 billion ene 2.995 billion W 33 1/2 energy slaves per capita.

However, these energy slaves were in their service to each man on the face tables above will show. Marked contras table, -e. g. each of the 199 million "No

Energy	Slaves	Population		% of World			% of World's			Slaves		
				Energy		Slaves	Energy (in terms of Human Equivalents)		Slaves	Per Captia		
	1950	1960										
, 000	3,090,000,000	5,050,000,000		6	5	5	108	110	168	2	2	3
, 000	18,544,000,000	52,100,000,000		42	34	52	756	736	1,747	29	32	81
, 0.00	961,000,OOO	2,515,000,000		1	2	2	18	44	67	3	5	10
, 000	29,850,000,000	36,800,000,000		48	55	37	864	1,195	1,243	.51	177	185
, 000	954,000,000	1,472,000,000		1	2	1	18	44	34	6	9	10
,000	577,000,000	1,850,000,000		1	1	2	18	22	67	8	11	28
,000	760,000,OOO	855,000,OOO		1	1	1	18	22.	34	41	58	52
,000	54,736,000,000	00,642,200,000		100%	100%	100%	1800%	2173%	3360%	18.00	2'1.73	33.6

therefrom, 3.7 quintillion
ounds

illion foot pounds (each
we receive the figure
f work being done for
ents we will call 100.6
energy slaves
on World population

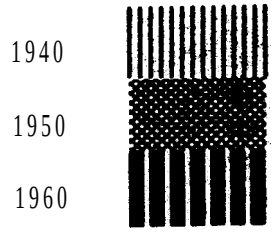
were not divided up equally
'ace of the earth as the
trasts are to be seen in the
"North American" inhabitants

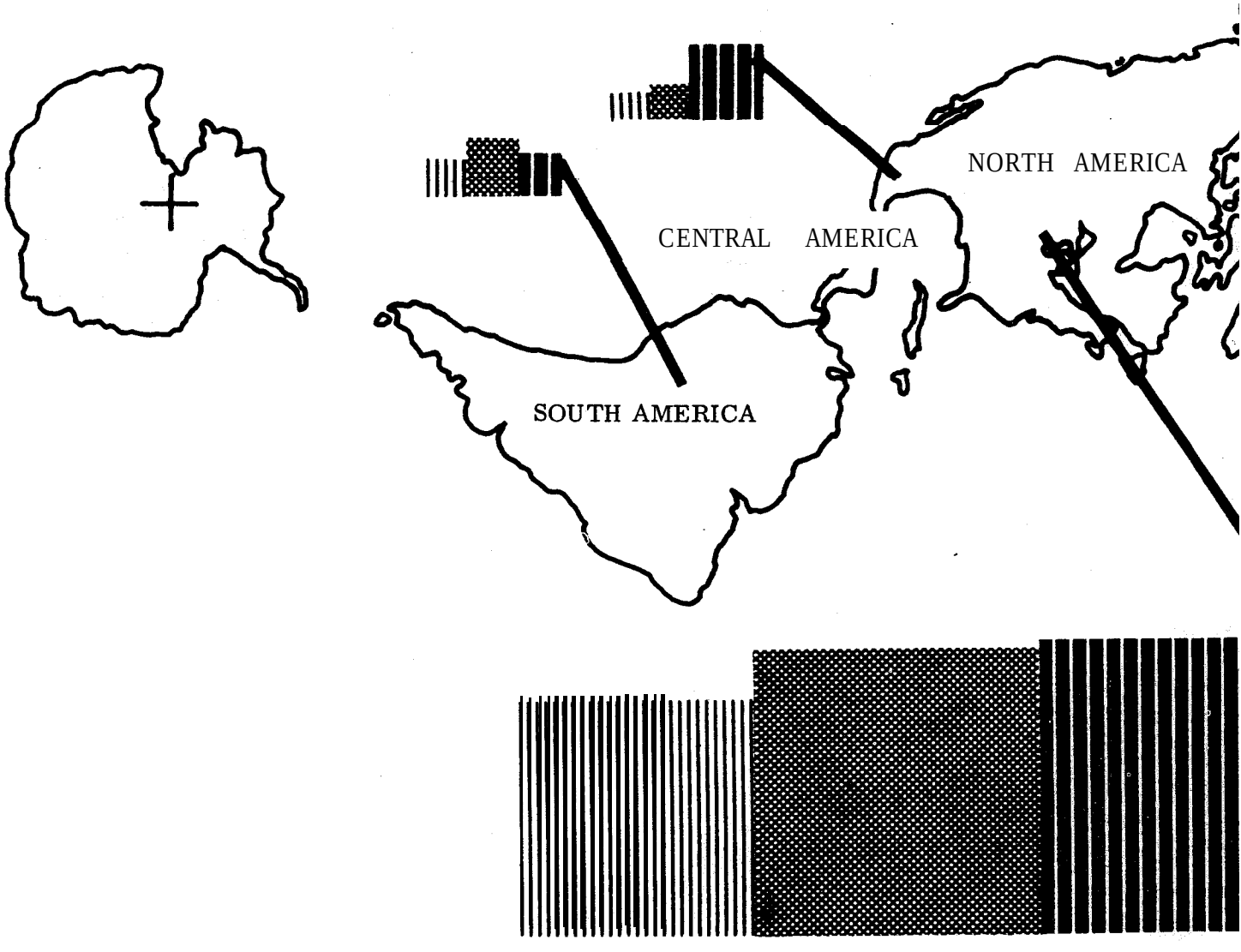
is served by 185 slaves (460 per family) while each of the inhabitants of "Asia" is now limited to the services of 3 slaves.

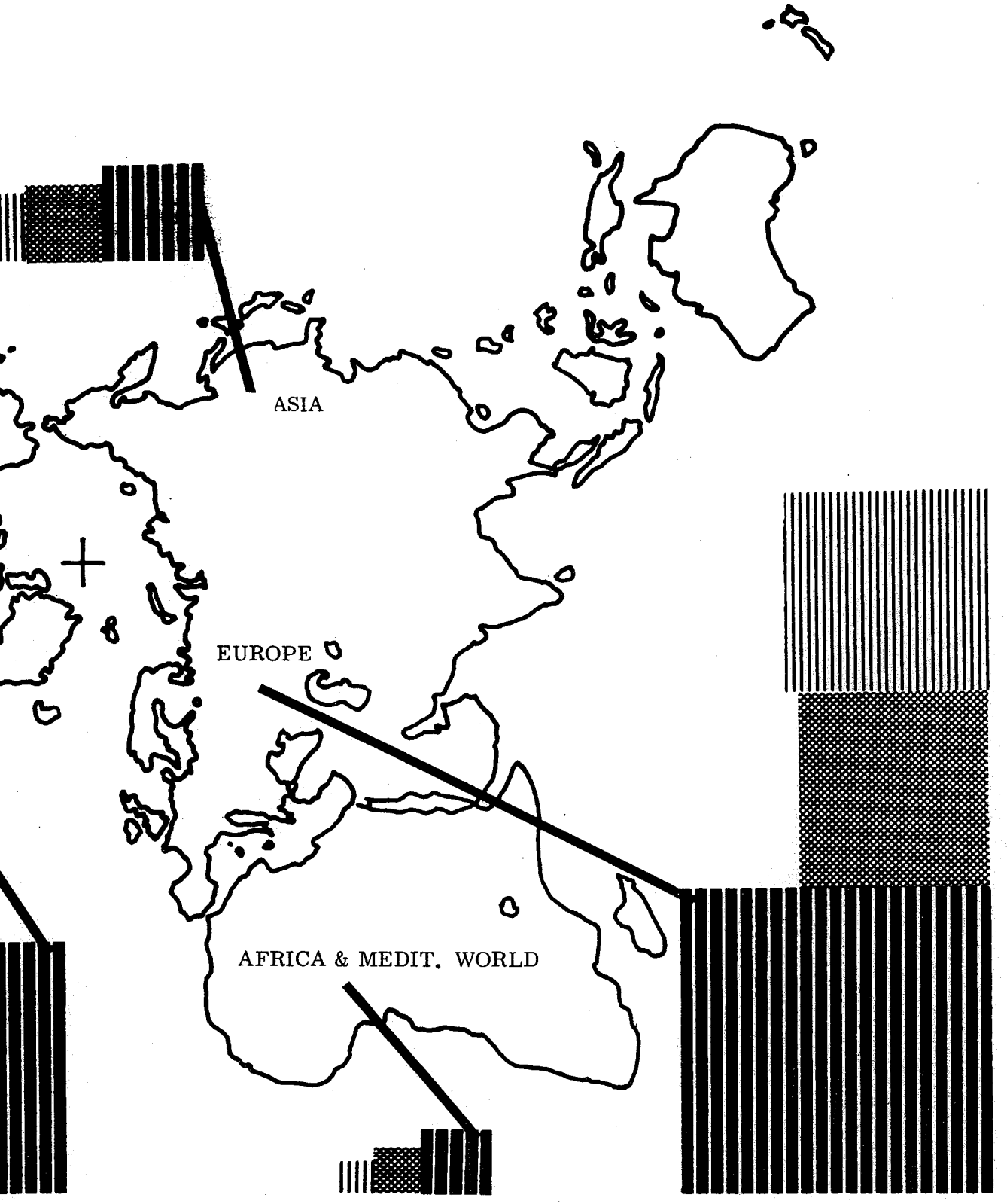
To furthur appreciate the significance of this table, it must be noted that "energy slaves", though doing only the foot pound equivalent of humans, are enormously more effective because they can work under conditions intolerable to man, e.g. 5000° fahrenheit, no sleep, ten-thousand&h of an inch tolerance, can see at one million magnifications of man's vision, 400,000 pounds per square inch sinuosity , 186,600 miles per second alacrity, etc. Because the slaves have become 50% more efficient between 1940 and 1960 the world's overall mechanical efficiency has been improved from 4% to 6%.

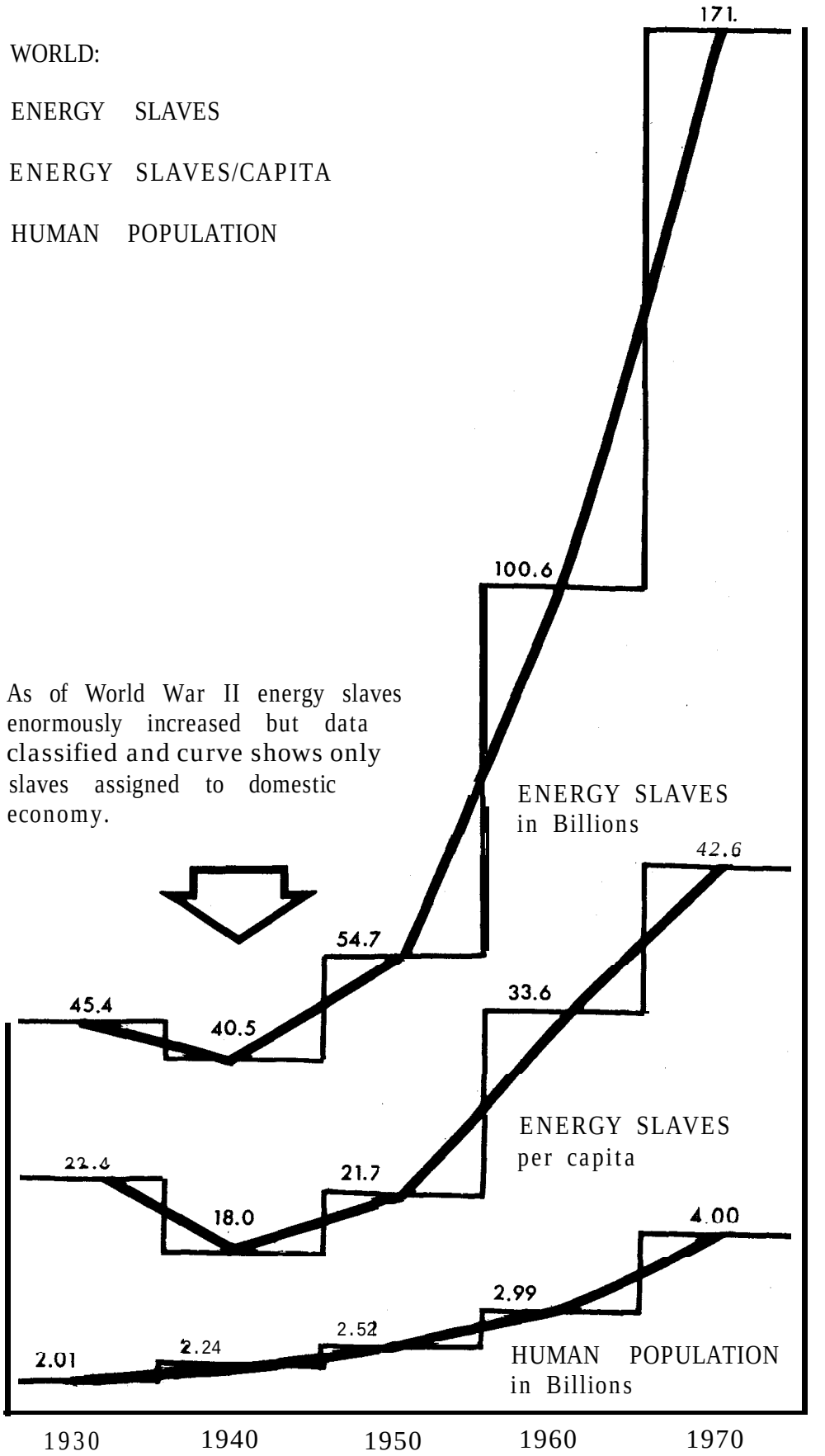
WORLD ENERGY MAP

per cent relation - energy slaves per capita
in terms of human equivalents

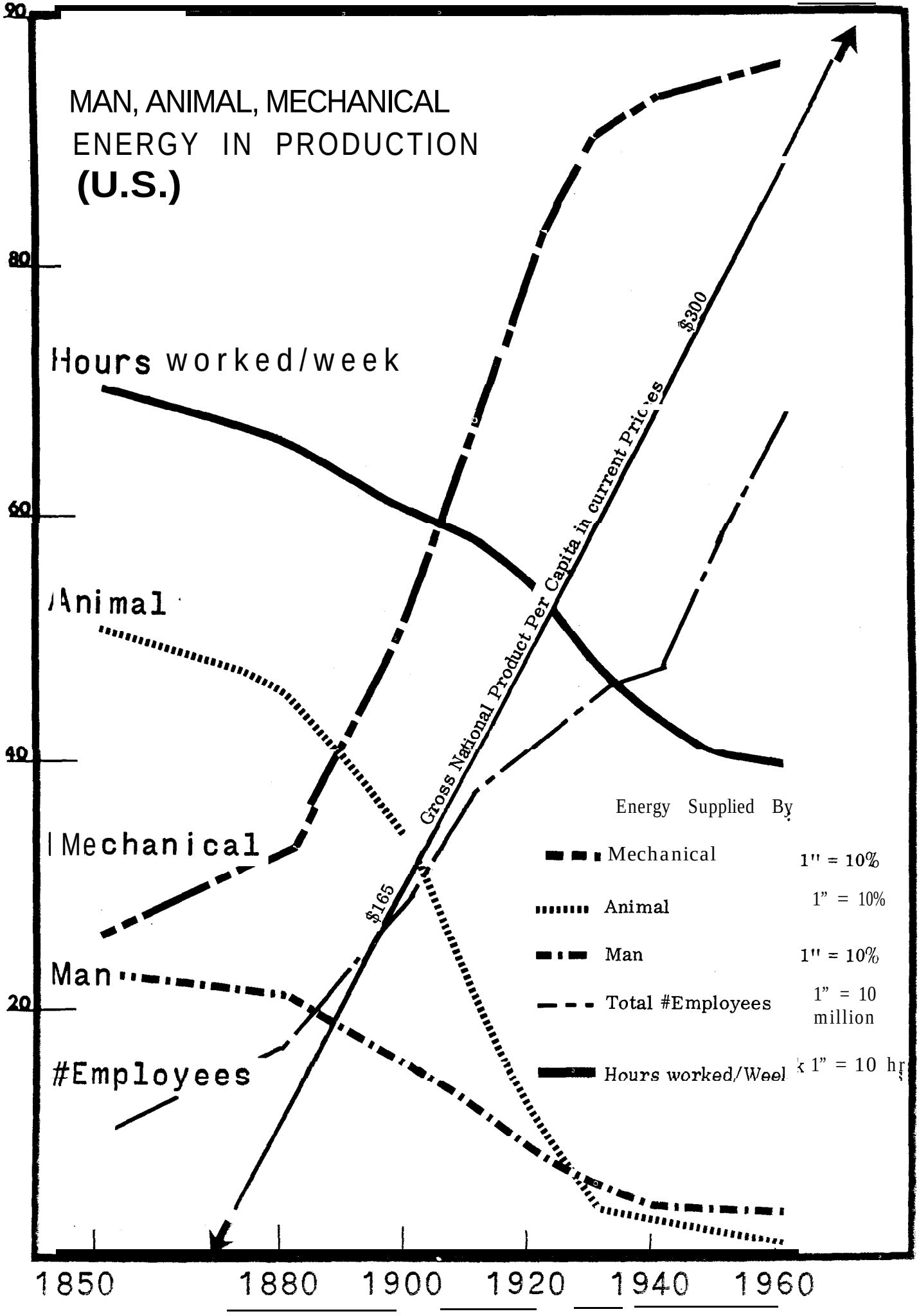





ASIA
EUROPE
AFRICA & MEDIT. WORLD


WORLD:
ENERGY SLAVES
ENERGY SLAVES/CAPITA
HUMAN POPULATION
As of World War II energy slaves enormously increased but data classified and curve shows only slaves assigned to domestic economy.
171.
100.6
54.7
45.4
40.5
ENERGY SLAVES
in Billions
42.6
33.6
22.4
21.7
18.0
ENERGY SLAVES
per capita
4.00
2.99
2.52
2.24
2.01
HUMAN POPULATION
in Billions
1930
1940
1950
1960
1970

This chart shows part of the automation picture. Human 'employment' now comes before and after the facts of 'manufacture' - first as an initiation of the new trending of technological advance invention, discovery, research and development: secondly as regenerative consumer. The 'employment' curve is in reality an independent line from a certain point in automatic control development, It represents regenerative investment of the wealth created by automation. Our present method of 'pay for work' through which we now distribute the wealth represents a timid fraction of such re-investment capacity. Un-employment is actually time secured, and should be re-invested in education. If only one person in one million made one new discovery or prime invention this would pay for all


MAN, ANIMAL, MECHANICAL
ENERGY IN PRODUCTION
(U.S.)
80
60
40
20
Hours worked/week
Animal
Mechanical
Man
#Employees
Gross National Product Per Capita in current Prices
$300
$165
Energy Supplied By
Mechanical 1" = 10%
Animal 1" = 10%
Man 1" = 10%
Total #Employees 1" = 10 million
Hours worked/Week 1" = 10 hr
1850
1880
1900
1920
1940
1960

WORLD RESOURCES, HUMAN TRENDS AND NEEDS

This section selects specific aspects of world material production and consumption, and their relation to human trends and needs. Its most immediate comment is contained within the group of charts of the major minerals and metals and their percentage output of world production listed by country. 1960 was chosen as a representative year.

This listing comprises the shelf inventory of the world's prime re-associable element patterns of the metals and minerals. It is the main 'menu' for industrial network consumption, and forcibly demonstrates that no one country is wholly self sufficient in these vital industrial ingredients. Close inspection will reveal surprising patterns, of past and present relevancy, in terms of world political preoccupations with seemingly backward and valueless territories, i. e., the recent Congo involvement. Gaps in the chart where no production figures are given for a country in any column indicate, either that no data is available for reasons of economic or political secrecy, or that the particular country has a deficiency of this ingredient. Resource statistics in many areas of the world have only been initiated in recent years and are still far from complete or wholly reliable.

The series of schematic world map&which follow the production charts indicate roughly the resource reserves of selected materials. When taken together these production and reserve relations may graphically demonstrate some of the basic conditions which made possible the rapid growth of industrialization in the high living standard countries. Most analyses of world resource deal in 'years of supply in exploitable reserve', e. g.,

aluminum -	570 yrs.
iron	250 yrs.
zinc	23 yrs.
copper	29 yrs.
lead	19 yrs.
tin	35 yrs. 2

This type of estimate, whilst useful for local economic purposes, omits two main relative factors. One, the progressive recycling of such materials as scrap, in the industrial process, which means that they are not really used up by extraction and manufacture but become above ground circulating reserves.

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1. These are included only as rough guides to the possible detailed worid resources and 'materials flow' mapping, which might be forwarded by each individual area engaged in the ten-year world student program. Such resource maps as generally available vary greatly in their area data,

2. Ref: Energy Resources: U. S. National Academy of Sciences. 1962.

U. S. lead scrap in the 1950% rivalled primary production and was an estimated 44 percent of the net supply of the metal in 1960[1]. The development of substitute and replacement. materials is also an important factor here. New materials, like the plastics range, may, as they become available,replace older metallic and mineral uses,and give, in addition, superior performance characteristics for particular usages.

The second factor is that mining and extraction has gone steadily towards the use of ores of decreasing material content. A century ago most copper ores processed were of not less than 10 percent copper - today the world average is approximately 1 1/2 percent. This entails more energy input for refined metal output. Our main resource picture shows that such energy, and more, is available potentially on a global scale. In addition, we constantly do *more with less' in the developing industrial process.

This *more with less' trending shows that even where material invested per capita goes down much more is done with this amount.

The real key to our resource inventory lies with 'this transformative industrial capacity'. We are now able to deal vigorously with the full inventory of elemenk associative patterns. Over 7,000 major material transformations are accomplished by modern chemistry. "The freely available materials of the earth - air, water, mineral and agricultural products, coal, petroleum and natural gas - are being transformed into innumerable products of benefit to man. Within the last 25 years petroleum and natural gas have become the raw materials for more than 2,500 different chemical products[2]." Coal is also the raw material for thousands of chemicals re-associated into preferred patterns as dyes, drugs, textiles and plastics.

Resource economists, generally, do not take into account these regenerative aspects of the evoluting industrial process and the complex interactions of the tools which create the real wealth. Their studies are not 'synergetic' but concerned with the local secondary cycles of money, credit flows, trade balances, etc. **Political** studies of resource tend in the same manner to be preoccuppied with their local, national, holdings - what the country or area actually 'has' at some hypothetical point in time whilst in the industrial network reality what you 'have' is a temporal and dynamic series of flow relationships which can only be related to what all other men 'have'.

1. Ref: Mineral Resources: U.S. National Academy of Sciences. 1962.

2. Ref: The Road to Abundance. J. Rosin: M. Eastman. Pub. Rider and Co. 1955.

WORLD PRODUCTION OF MAJOR MINERALS AND METALS BY COUNTRY

WORLD PRODUCTION OF MAJOR MINERALS AND METALS BY COUNTRY
(Revised for 126 Countries in 1966 Reprinting)

Each of the three following pages include eighty-four countries and forty metals, minerals or mineral products.

World totals in actual amount appear below each of the forty major metal or mineral headings and are followed by an abbreviated symbol which designates its bulk or weight unit. The listing below correlates each symbol with its unit of measure and its U. S. and metric equivalent.

Symbol	Unit of Measure		U. S. Equivalent		Metric Equivalent
S. T.	Short Ton	=	2,000 lbs.	=	.907 metric ton
L. T.	Long Ton	=	2,240 lbs.	=	1.016 metric ton
B. B. L.	Barrel	=	376 lbs. = 4 bgs. cement	=	170.55 kilograms
		=	42 gal. per B. B. L. of petroleum	=	139.07 kilograms
C.	Carat	=	200 milligrams	=	200.00 milligrams
T. 0.	Troy Ounce	=	l/12 troy lb.	=	31.10 grams
		=	(troy lb. = .823 lb. avoirdupois)	=	373.24 grams
F.	Flask	=	76 lbs.	=	34.55 kilograms

All country entries are given in percent of world total.

Leading world producers in each category are indicated by an asterisk. (*)

Source: Mineral Yearbook, 1965, Vols. I and II, Bureau of Mines, U. S. Department of the Interior.

	ALUMINUM 6,080,000 S. T.	ANTIMONY 61,600 S. T.	ASBESTOS 3,210,000 S. T.	BAUXITE 30,220,000 L. T.	CEMENT 2,209,950,000 BBLS.	CHROMITE 4,355,000 S. T.	COAL - ANTHRACITE 2,140,349,000 S. T.	COAL - LIGNITE 786,321,000 S. T.	COBALT 12,900 S. T.
AFGHANISTAN					.027		.005		
ALBANIA					.034	7.416		.042	
ALGERIA					.234		.002		
ANGOLA					.051				
ARGENTINA			.006		.668		.010		
AUSTRALIA	.760	.134	.416	1.171	.827	.004	1.300	2 .628	.147
AUSTRIA	1.386	.889	.021	.059	.878		.005	.848	
BECHUANALAND			.073						
BELGIUM					1.249		1.103		
BOLIVIA		13.534	.000		.016				
BRAZIL	.319		.044	.552	1.375	1.114	.132		
BULGARIA			.034		.585		.033	2.842	
BURMA		.204			.032		.000		
CAMBODIA									
CAMEROON	.959								
CANADA	11.832	1.300	39.769*		1.688		.406	.238	11.720
NT. AFRICAN REP.									
CEYLON					.019				
CHAD									
CHILE					.309		.088		
CHINA	1.809	26.785*	3.426	1.323	2.653		14.016		
COLOMBIA					.486	.002	.154		
O (BRAZZAVILLE)									
(LEOPOLDVILLE)					.065		.004		63.031*
CUBA					.092	1.281			1.488
CYPRUS			.621		.025	.010			
CZECHOSLOVAKIA	1.069	3.571			1.373		1.457	10.276	
DOMINICAN REP.				2.518	.060				
ECUADOR					.068				
ELSALVADO R					.020				
ETHIOPIA					.009				
FIJI ISLANDS									
FINLAND		.178	.314		.376				
FRANCE	5.409		.830	6.608	4.722		2.459	.346	
GABON									
GERMANY (EAST)	.822				1.448		.127	35.663*	
GERMANY (WEST)	3.785			.013	7.751		7.319	14.951	
GHANA				.684					
GREECE				4.172	.608	.421		.487	
GREENLAND							.002		
GUATEMALA		.050		5.420	.041				
GUINEA									

COPPER (MINED) 5,210,000 S. T.	DIAMONDS IND. 30,067,000 C.	FELDSPAR 1,690,000 L. T.	FLOURSPAR 2,340,000 S. T.	GOLD 44,200,000 T. O.	GYPSUM 49,900,000 S. T.	IRON ORE 513,661,000 L. T.	LEAD 2,805,000 S. T.	MAGNESITE 9,200,000 S. T.	MANGANESE 16,138,000 S. T.	MERCURY 239,000 F.
.053						.057				
.021	1.080				.434	.378	.315			
.002				.000		.122				
.002		.174	.415	.001	.347	.018	1.033		.102	
2.423		.523		2.314	1.714	1.073	16.383*	.639	.251	
.039		.122			1.434	.715	.196	15.729		
				.000					.073	
						.018				
.063				.346			.792			
.032	.582	2.307		.298	.293	2.149	.685	1.081	8.568	
.406					.244	.125	3.493		.262	
.003				.000			1.026		.001	
				.015						
				.004						
8.686		.454	3.632	8.986	13.262	5.239	7.094			
	.937			.000						
		.006								
12.782		.024		.174	.258	1.630	.034		.317	.256
1.900			9.401	.135	1.244	6.697	3.921	10.760	6.828	10.878
		.727		.734	.249	.133	.000	.003		.001
.006	17.770			.006			.012			
5.740	48.119*			.485					1.844	
.115						.000			.516	
.556					.244					
					.741	.653	.531	6.304		.303
					.086					
.006				.047			.006			
		.028		.061						
				.242		.000			.022	
.717		.746		.046		.070	.044			
.005		10.104	6.850	.121	10.331	11.092	.329			
				.080					4.414	
.508			3.418		.632	.318	.295			
.046		15.687	4.095	.004	2.601	2.471	2.037			
	7.124			2.084					2.691	
					.233	.006	.518	2.989	.101	
						.001	.029			
	.106					.126				

	MICA 400,000,000 LBS.	MOLYBDENUM 90,900,000 LBS.	NATURAL GAS 21,916,478 MIL. CU. FT.	NICKEL 395,000 S. T.	NITROGEN 19,881,000 S. T.	PETROLEUM 9,537,420,000 BBLS.	PHOSPHATE ROCK 0,590,000 L. T.	PLATINUM 1,545,000 T. O.	POTASH
AFGHANISTAN									
ALBANIA				.835		.055			
ALGERIA			.067			1.932	.677		
ANGOLA						.060			
ARGENTINA	.018		.549			1.019	.001		
AUSTRALIA	.275		.289		.105		1.296		
AUSTRIA					1.101	.191			
BECHUANALAND									
BELGIUM					1.765		.027		
BOLIVIA						.034			
BRAZIL	.822		.085	.287	.140	.374	.543		
BULGARIA					.573	.013			
BURMA			.002	.028		.049			
CAMBODIA									
CAMEROON									
CANADA	.295	.917	5.098	55.681*	2.716	2.709		23.148	5.
CENT. AFRICAN REP.									
CEYLON									
CHAD									
CHILE		7.040	.877		.970	.138	.071		.
CHINA		3.630			2.494	.574	1.383		
COLOMBIA			.119			.632		1.906	
CONGO (BRAZZAVILLE)						.098			
CONGO (LEOPOLDVILLE)									
CUBA				4.658	.165	.009			
CYPRUS									
CZECHOSLOVAKIA			.912		.890	.012			
DOMINICAN REP.									
ECUADOR						.035			
EL SALVADOR									
ETHIOPIA								.011	
FIJI ISLANDS									
FINLAND				.861	.256				
FRANCE	.095		.889		6.081	.189	.098		17.4
GABON			.001			.067			
GERMANY (EAST)				.027	2.117				16.8
GERMANY (WEST)	.005		.155		8.747	.359			17.7
GHANA									
GREECE					.030				
GREENLAND									
GUATEMALA									
GUINEA									

SALT 104,700,000 S. T.	SILVER 250,800,000 T. O.	STEEL 425,470,000 S. T.	SULFUR 12,600,000 L. T.	THORIUM N. A.	TIN (MINED) 190,315 L. T.	TITANIUM 2,408,600 S. T.	TUNGSTEN 64,600 S. T.	URANIUM 30,200 S. T.	VANADIUM 7,155 S. T.	ZINC 4,020,000 S. T.
.034										
.136	.109									.995
.072										
.177	.771	.236	.175		.115		.246	.036	.083	.786
.623	7.807	1.204		NA	1.498	18.125 *	2.775	3.973		9.791
.362	.027	.763					.380			.194
	.000									
		1.950								
	1.935		.077		11.954		3.890			.127
1.255	.135	.734		NA	.604	.014	.947			
.110		.119	.049							2.018
.169	.828				.525		1.280			.221
					.015					
3.554	11.897	1.924	8.856		.217	15.749		26.956		12.367
.023						.873				
.026										
.050	1.103	.126	.459							.013
11.079	.318	3.055	1.984		14.712		38.544*			2.736
.312	.042	.057	.101					NA		.002
					.022					.019
	.437				3.616		.345	NA		2.839
.084										
.007										
.196	.641	1.968			.105			NA		
.034										
.037	.048									
.019										
.268										
	.018									
	.231	.081	.298			4.295			10.775	1.819
3.889	.291	4.515	11.002		.145		1.195	6.692		.499
2.101	1.913	.939	.937		.378			NA		.273
5.883	.824	8.816	.674					NA		2.555
	.001									
.089	.062	.054								.499
.020	.025									.032

	ALUMINUM 6,080,000 S. T.	ANTIMONY 61,600 S. T.	ASBESTOS 3,210,000 S. T.	BAUXITE 30,220,000 L. T.	CEMENT 2,209,950,000 BBLS.	CHROMITE 4,355,000 S. T.	COAL - ANTHRACITE & BITUM. 2,140,349,000 S. T.	COAL - LIGNITE 786,321,000 S. T.	COBALT 12,900 S. T.
GUYANA				7.749					
HAITI				1.082	.012				
HONDURAS					.015				
HONG KONG					.057				
HUNGARY	1.006			4.434	.477		.191	3.739	
INDIA	1.000		.093	1.839	2.482	1.639	3.394	.139	
INDONESIA				1.604	.087		.030		
IRAQ					.197	2.525	.010		
IRAN					.239				
IRELAND					.212		.010		
ISRAEL					.271				
ITALY	1.657	.431	1.975	.876	5.860		.030	.191	
IVORYCOAST									
JAMAICA				22.842*	.053				
JAPAN	4.060	.344	.567		7.945	1.106	2.654	.128	
JORDAN					.075				
KENYA			.002		.090 I				
KOREA(NORTH)					.671		.722		
KOREA (SOUTH)			.066 I		.206		.456		
KUWAIT									
LAOS									
LEBANON					.237				
LIBERIA									
LIBYA									
LUXEMBOURG					.053				
MALAGASY REP.					.006	.283	.000		
MALAWI									
MALAYSIA				1.982	.096				
MALI									
MAURITANIA									
MEXICO	.100	8.636			.976		.106		
MOROCCO		1.207			.201		.020		11.713
MOZAMBIQUE				.019	.044		.014		
NETHERLANDS					.552		.592		
NEW CALEDONIA			.013						
NEW ZEALAND					.191		.134	.023	
NICARAGUA					.014				
NIGER									
NIGERIA					.139		.029		
NORWAY	3.973				.373				
PAKISTAN		.014			.397	.367	.064		
PANAMA					.037				

COPPER (MINED) 5,210,000 S. T.	DIAMONDS IND. 30,067,000 C.	FELDSPAR 1,690,000 L. T.	FLOURSPAR 2,340,000 S. T.	GOLD 44,200,000 T. O.	GYPSUM 49,900,000 S. T.	IRON ORE 513,661,000 L. T.	LEAD 2,805,000 S. T.	MAGNESITE 9,200,000 S. T.	MANGANESE 16,138,000 S. T.	MERCURY 239,000 F.
	.133			.006					.974	
.125				.015						
				.005			.389			
		.099				.021				
						.140			1.040	
.211		1.219		.312	2.915	3.817	.169	2.810	8.057	
				.010					.011	
					2.449		.392		.006	
					1.224					
					.487					
.163			5.864		.256					
.051		5.929			5.089	.192	1.292	.081	.309	22.781
	.389								.949	
					.570					
2.268		3.156	.984	.539	1.922	.464	2.071		1.890	1.953
				.023				.003		
.168			1.410	.361		.739	1.960	9.565		
.013		.674	1.874	.203		.095	.075		.028	
	1.689			.004		1.256				
						1.339				
				.002						
				.026		1.414			.047	
						.273				
1.181			22.687*	.538	2.694	.446	7.466		1.173	6.820
.038			.299			.198	2.906		2.287	
				.000						
						.057				
				.032				.009		
.154				.463						
				.000						
.301		3.846				.376	.137			
		.072			.485			.010	.009	

	MICA 400,000,000 LBS.	MOLYBDENUM 90,900,000 LBS.	NATURAL GAS 21,916,478 MIL. CU. FT.	NICKEL 395,000 S. T.	NITROGEN 19,881,000 S. T.	PETROLEUM 9,537,420,000 BBLS.	PHOSPHATE ROCK 50,590,000 L. T.	PLATINUM 1,545,000 T. O.	POTASH 12,100,000 S. T.
GUYANA									
HAITI									
HONDURAS									
HONG KONG									
HUNGARY			.104		.492	.140			
INDIA	18.780				1.388	.128	.025		
INDONESIA			.476	.446	.085	1.730	.011		
IRAQ			.495			5.642			
IRAN						4.430			
IRELAND									
ISRAEL			.001		.145	.011	.583		1.029
ITALY			1.237		4.999	.127			1.715
IVORY COAST									
JAMAICA									
JAPAN		.805	.288		7.318	.057		.196	
JORDAN							.800		
KENYA	.000								
KOREA (NORTH)					.497		.395		
KOREA (SOUTH)		.169			.316				
KUWAIT						7.396			
LAOS									
LEBANON									
LIBERIA									
LIBYA						1.759			
LUXEMBOURG									
MALAGASY REP.	.532								
MALAWI									
MALAYSIA						.310			
MALI									
MAURITANIA									
MEXICO		.099	1.936		.553	1.204	.059		
MOROCCO			.001	.446		.011	16.629		
MOZAMBIQUE									
NETHERLANDS			.036		2.750	.161			
NEW CALEDONIA				10.430					
NEW ZEALAND			.000			.000			
NICARAGUA									
NIGER									
NIGERIA			NA			.289			
NORWAY		.487			1.951				
PAKISTAN	.000		.225		.482	.036			
PANAMA									

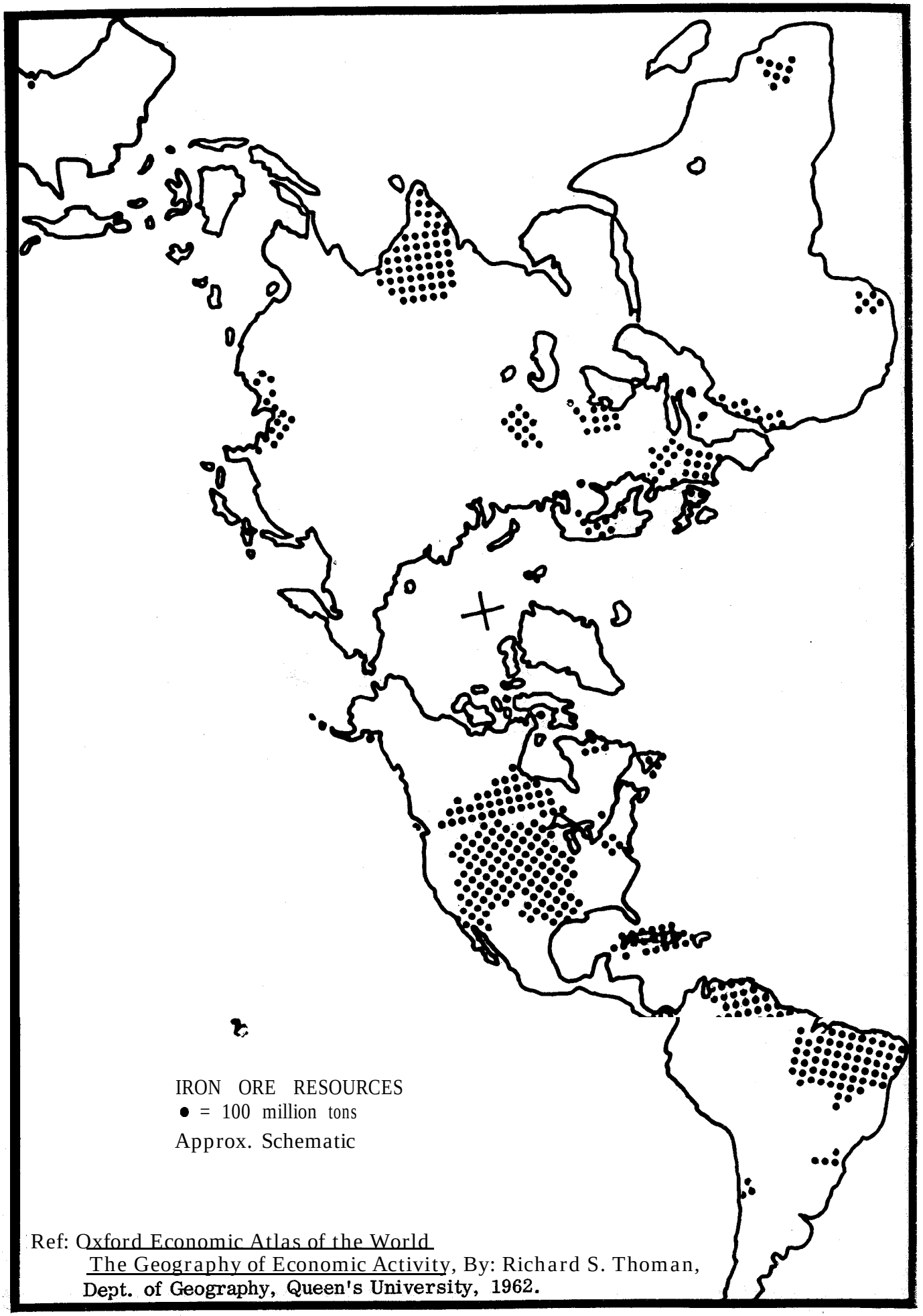
SALT 104,700,000 S. T.	SILVER 250,800,000 T. O.	STEEL 425,470,000 S. T.	SULFUR 12,600,000 L. T.	THORIUM N. A.	TIN (MINED) 190,315 L. T.	TITANIUM 2,408,600 S. T.	TUNGSTEN 64,600 S. T.	URANIUM 30,200 S. T.	VANADIUM 7,155 S. T.	ZINC 4,020,000 S. T.
.010	.042									
.010	1.706									.204
							.013			
	.025	.615						NA		.071
4.788	.051	1.546		NA		1.273	.009	NA		.160
.319	.111			NA	6.802					
.362			.158							.273
.042										
		.005								
.054		.017								
3.306	.401	2.631	.342			.000		NA		2.934
.836	3.513	8.161	1.829		.450	.039	1.325	NA		5.428
.019										
.034	.020									
.477	.255	.264					6.811			2.736
.242	.177	.041		NA			9.430			.030
					.171					
.020										
.020										
		1.044								
.018				NA		.167				
				NA	31.498*	6.836	.012			
1.289	17.049*	.525	12.134		.554	.006	.055			6.575
.039	.308				.005					.905
.029				NA						
1.556		.606	.273							
.011	.000						.009			
.017	.161									
					.028					
				NA	4.583					
		.140				11.089				.340
.478										
.010										

	MICA 400,000,000 LBS.	MOLYBDENUM 90,900,000 LBS.	NATURAL GAS 21,916,478 MIL. CU. FT.	NICKEL 395,000 S. T.	NITROGEN 19,881,000 S. T.	PETROLEUM 9,537,420,000 BBLS.	PHOSPHATE ROCK 50,590,000 L. T.	PLATINUM 1,545,000 T. O.	POTASH 12,100,000 S. T.
PARAGUAY									
PERU		1.292	.170		.100	.225	.373		
PHILIPPINES		.259			.045		.003		
POLAND			.160	.354	1.896	.016	.126		
PORTUGAL					.633				
QATAR						.735			
RHODESIA				.033					
ROMANIA			1.720			.956			
RWANDA & BURUNDI									
SAUDI ARABIA						6.234			
SENEGAL							1.160		
SIERRA LEONE									
SOMALI REP.									
SOUTH AFRICA	1.179			.683	.663		.885	19.773	
SOUTHWEST AFRICA	.299						.001		
SPAIN					1.031				2.370
SPAN. SAHARA									
SUDAN									
SURINAM									
SWAZILAND									
SWEDEN					.347				
SWITZERLAND					.140				
SYRIA									
TAIWAN			.008		.558	.000			
TANZANIA	.059								
THAILAND									
TOGO							2.077		
TRINIDAD & TOBAGO			.135			.510			
TUNISIA			.001				4.611		
TURKEY						.053			
UAR (EGYPT)					.663	.406	1.253		
UGANDA							.013		
UNITED KINGDOM			NA		4.501	.009			
UPPERVOLTA									
URUGUAY									
USA	54.687*	71.519*	67.285*	2.895	28.665*	28.862*	39.246*	3.220	23.669*
USSR		13.751	15.580	22.784	9.717	15.772	21.407	51.779*	14.049
VENEZUELA			1.050			12.430			
VIET NAM (NORTH)							1.559		
VIET NAM (SOUTH)									
YUGOSLAVIA	.019		.032		.387	.125			
ZAMBIA									

SALT 104,700,000 S. T.	SILVER 250,800,000 T. O.	STEEL 425,470,000 S. T.	SULFUR 12,600,000 L. T.	THORIUM N. A.	TIN (MINED) 190,315 L. T.	TITANIUM 2,408,600 S. T.	TUNGSTEN 64,600 S. T.	URANIUM 30,200 S. T.	VANADIUM 7,155 S. T.	ZINC 4,020,000 S. T.
.091	14.673	.018			.011		.885			5.382
.073	.308		.000							.106
2.243	.051	2.073	1.837							4.033
.365	.019		.023		.377	.001	2.761	NA		.004
	.033	.012			.261		.004			
1.723	.256	.700								
					.667		.021			
.010										
.063						.590				
.208	1.091	.734	.015	NA	.803	1.346	.013	15.006	19.440	
.068	.252				.232		.369		15.849	.913
1.787	1.975	.645	.539		.083	2.314	.250	.182		2.515
.039										
	.000				.001					
	1.428	1.010	.205				.588	.033		2.232
.201		.080								
.016										
.659	.024	.071	.075							
.035	.009				.124					
.210		.001			8.190		.352			.023
			.055							
.316	.003									.119
.419		.094	.151							.125
.412		.051	.055	NA		.024				
.002	.000				.085					
6.837		5.928	.369		.644					
29.273*	13.955	25.680*	46.259*	NA		4.164	8.756	47.079*	53.850*	13.165*
9.216	10.765	20.777	10.714	NA	10.508	NA	18.730	NA		11.194
.080		.094								
.134										
.134										
.175	1.511	.411					.029			1.679
	.352									1.047

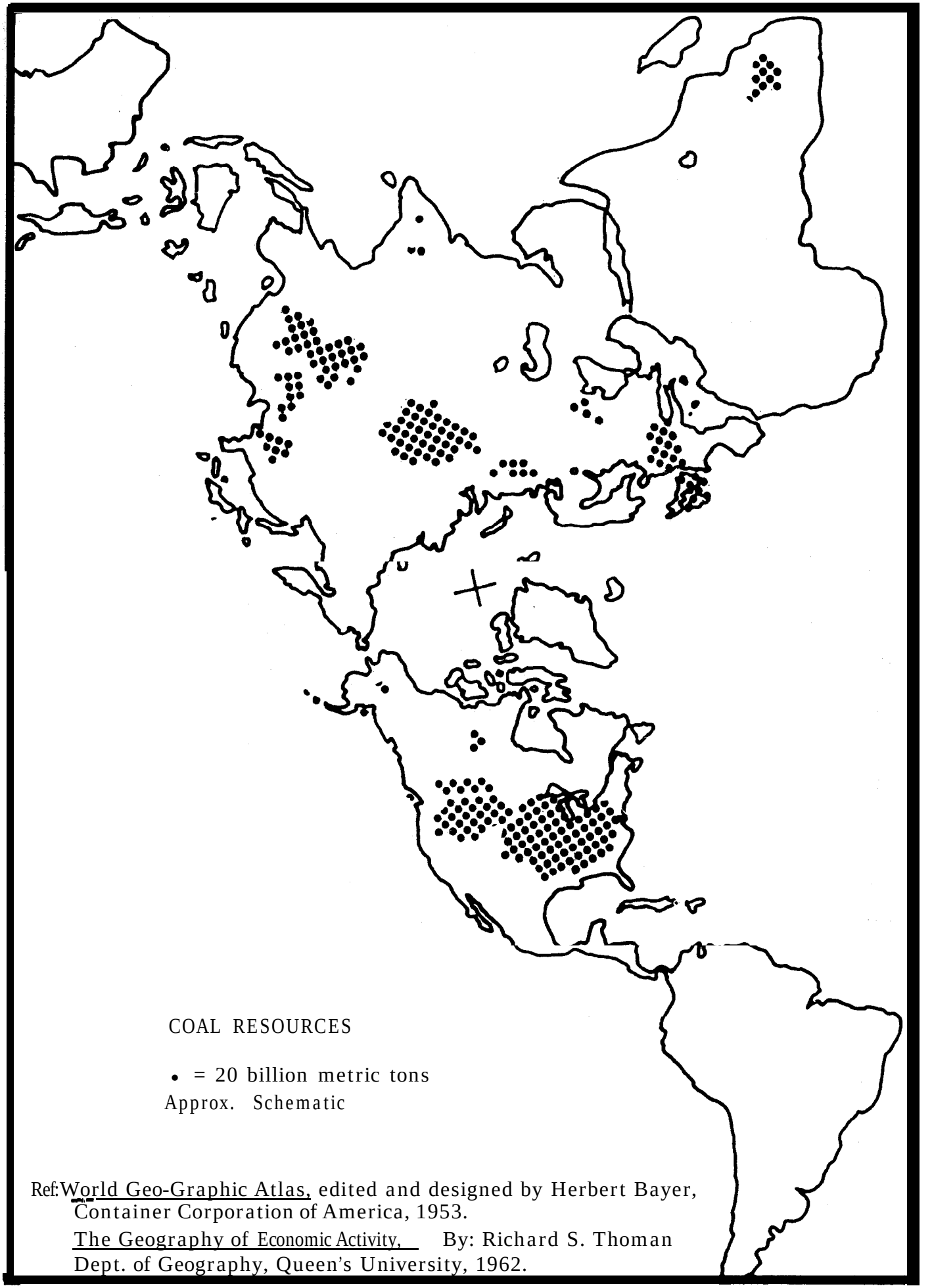
	ALUMINUM 6,080,000 S. T.	ANTIMONY 61,600 S. T.	ASBESTOS 3,210,000 S. T.	BAUXITE 30,220,000 L. T.	CEMENT 2,209,950,000 BBLS.	CHROMITE 4,355,000 S. T.	COAL - ANTHRACITE 2,140,349,000 S. T.	COAL - LIGNITE 786,321,000 S. T.	COBALT 12,900 S. T.
PARAGUAY					.004				
PERU		1.323			.200		.006		
PHILIPPINES			.013		.252	11.620	.008		
POLAND	.844		.000		2.034		5.827	2.151	
PORTUGAL					.380		.021	.019	
QATAR									
RHODESIA		.107	4.431	.006	.066	9.469	.141		
ROMANIA				.033	1.159		.291	.646	
RUANA-UR UNDI									
SAUDI ARABIA					.049				
SENEGAL					.050				
SIERRA LEONE				.066		.070			
SOMALI REP.									
SOUTH AFRICA		20.146	6.409		.765	20.050	2.186		
SOUTHWEST AFRICA									
SPAIN	.824	.105		.039	2.055		.664	.363	
SPAN. SAHARA									
SUDAN					.026	.429			
SURINAM				11.426					
SWAZILAND			1.038						
SWEDEN	.331				.862		.005		
SWITZERLAND	1.109				.950				
SYRIA					.181				
TAIWAN	.216		.018		.595		.247		
TANZANIA							.000		
THAILAND		1.097			.264		.007		
TOGO									
TRINIDAD & TOBAGO					.042				
TUNISIA					.095				
TURKEY		3.215	.012		.715	7.182	.350	.699	
UAR (EGYPT)					.670				
UGANDA					.014				
UNITED KINGDOM	.563				3.714		10.245		
UPPER VOLTA									
URUGUAY					.090				
USA	38.035*	1.047	2.068	5.046	16.670*		22.168*	.344	NA
USSR	18.092	10.876	37.383	14.228	16.188	31.113*	20.349	19.148	NA
VENEZUELA					.416		.002		
VIET NAM (NORTH)					.132	.766	.173		
VIET NAM (SOUTH)							.005		
YUGOSLAVIA	.650	4.761	.282	4.185	.749	2.373	.066	3.663	
ZAMBIA					.031				6.031

COPPER (MINED) 5,210,000 S. T.	DIAMONDS IND. 30,067,000 C.	FELDSPAR 1,690,000 L. T.	FLOURSPAR 2,340,000 S. T.	GOLD 44,200,000 T. O.	GYPSUM 49,900,000 S. T.	IRON ORE 513,661,000 L. T.	LEAD 2,805,000 S. T.	MAGNESITE 9,200,000 S. T.	MANGANESE 16,138,000 S. T.	MERCURY 239,000 F.
3.754		.018		.228		1.259	5.827		.002	1.292
1.355		.388		.850		.265	.002		.052	.259
.280		1.556			1.436	.499	1.520	.318		
.011		.023		.049		.043	.008		.058	
.354			.014	1.281		.125		.131		
						.438	.491		1.775	
				.001						
	2.770					.366				
1.166	8.577	2.448	2.468	62.062*	.461	.854	.000	1.177	8.932	
.686	.395	.130	.020	.000			2.883			
.504		.738	7.226	.035	9.483	.995	2.444	1.014	.104	23.830*
				.002						
				.008						
				.004						
.403		2.668	.141	.290		4.528	2.699			
					.244	.018				
.034				.071		.000				
	1.041			.232				.001		
			1.376			.003	.088		.045	
						.165	.559			
.543			.030		.440	.143	.100	.214	.043	1.272
					1.153	.092			.147	
.343				.000						
			3.627		10.171	2.903	.019			
				.101						
		.016								
23.285*		32.482*	8.544	3.322	23.135*	14.328	9.032	5.735	.065	7.998
14.779	9.179	11.538	12.820	11.538	10.407	26.341*	13.903	32.391*	45.513*	14.644
	.103					2.250				
1.313		1.740		.189	.347	.440	3.991	4.935	.055	6.626
12.442				.011			.770		.240	



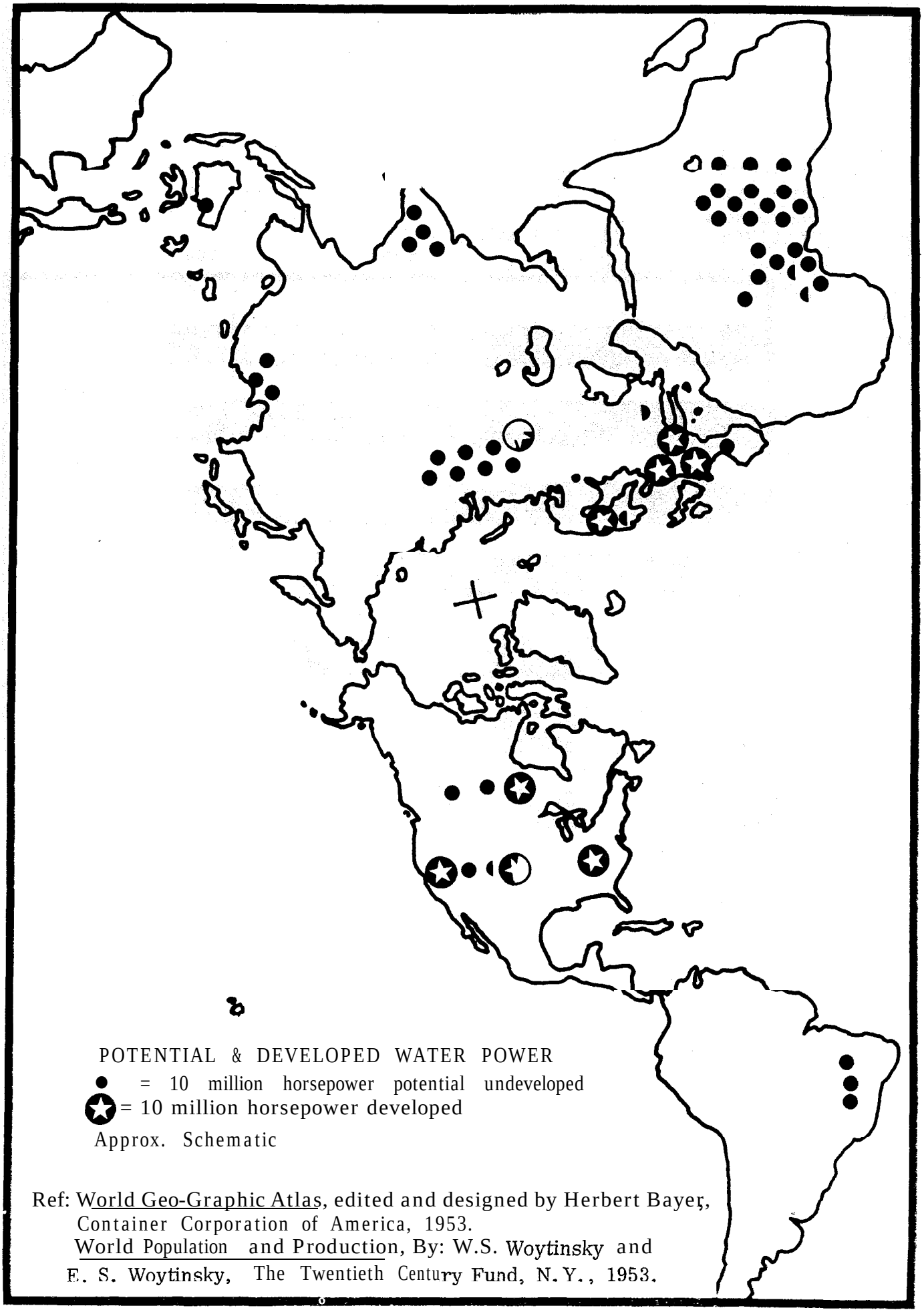
IRON ORE RESOURCES
● = 100 million tons
Approx. Schematic

Ref: Oxford Economic Atlas of the World
The Geography of Economic Activity, By: Richard S. Thoman, Dept. of Geography, Queen's University, 1962.



Ref: World Geo-Graphic Atlas, edited and designed by Herbert Bayer, Container Corporation of America, 1953.

The Geography of Economic Activity, By: Richard S. Thoman Dept. of Geography, Queen's University, 1962.



POTENTIAL & DEVELOPED WATER POWER

● = 10 million horsepower potential undeveloped

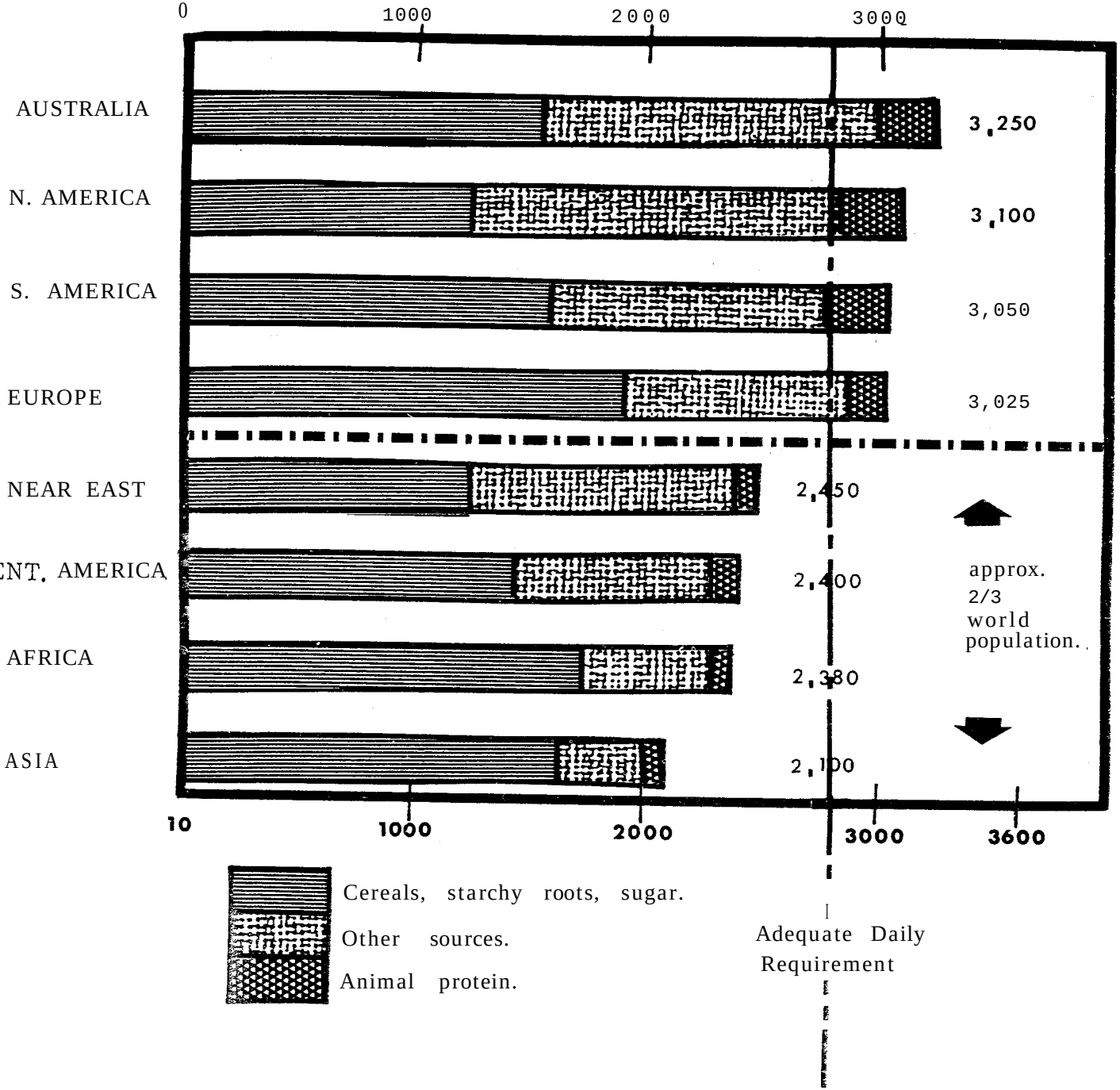
✪ = 10 million horsepower developed

Approx. Schematic

Ref: World Geo-Graphic Atlas, edited and designed by Herbert Bayer, Container Corporation of America, 1953.

World Population and Production, By: W.S. Woytinsky and E. S. Woytinsky, The Twentieth Century Fund, N.Y., 1953.

WORLD : CALORIES PER CAPITA, PER DAY, PER AREA.



Great concern has been voiced about the impending population explosion and our negligible chances of being able to feed, clothe and adequately shelter the growing millions. Much of this concern is an obvious hangover from the famous study of the Rev. Thomas Malthus[1] which suggested that human population would increase beyond the limits of the earth's capacity to sustain it, and mankind would ultimately perish. Compounded in the 19c with over-simplified versions of Darwin's 'survival of the finest', this seemed to indicate that the 'have' nations should necessarily look after their own,and let the less fortunate sections of the world fend for themselves.

We know, now, simply on the basis of our existing industrial and agricultural capacity, that this Malthusian view is quite erroneous. We can accommodate much larger numbers of people and at vastly increased standards of living than were even dreamt of in preceding centuries.

This dawning awareness of our real potential has been particularly evident to world around scientists for some time, It may be appropriate here to quote an extract from the views of E. K. Fedorov, Secretary General of the USSR Academy of Sciences, published in U.S. Saturday Review of Sept. 1, 1962: -

"It seems to me that . despite limits to the natural resources on our planet, the possibilities of satisfying the fundamental needs of society (in energy, food, and materials) are increasing rather than diminishing all the time on a per capita basis. There is no reason for expecting any diminuation of these possibilities in the visible future. Thus there are and have been, no grounds for considering the limits to our natural resources as a cause for any deficiency or misfortune in the life of mankind. In the remote future, the size of the earth may indeed prove to be the only restrictive factor. "

The precise rise in the population estimate itself varies from source to source as complete reliable data has again, only recently been tabulated. Within present forecasts, also, little weighting is given to the fact that life expectancy has increased spectacularly in the industrial countries hence there are more people alive, but older - the increase is not all contained within birth rate estimates at the base of the scale but is also at the top. A relation exists between increased industrial productivity and corresponding decrease in human reproduction. Studies conducted in Europe, North America and the British Commonwealth show that there is a sharp decline in birth rate which corresponds with those family units receiving the largest share of increased output. At the present time it seems, 'that the most which can be said is that where the per capita production of energy reaches the level reached earlier in areas like North Europe and the United States, and is simularly distributed, fertility

1. "An essay on the principle of population as it effects the future improvement of society with remarks on the speculations of Mr. Godwin, M. Condorcet and other writers." R. Malthus. 1798.

will probably decline[1]."

The pressing problem of adequate nourishment for the greater part of the world cannot be solved simply in terms of increased yield per acre or more extensive cultivation. This picture is, again, obscured by the artificial credit and tariff controls which still enmesh each major producing country and prevent full use of food land and produced surpluses.

Suggestions like the extension of intensive hoe cultivation, as practiced in the East, because it apparently yields more per acre than Western mechanized farming are not real solutions. Distortion occurs here, for example in statistical analyses, -- the top 4 percent of large scale mechanized producing units in the United States account for approximately 80 percent of the country's enormous total yield. The remainder of producers still figure in the weighted average though they range up and down the scale from wealthy business executives holding large acreage relatively unworked, to other part-time farmers whose real work occupation is in industry.

Adequate food supply may not be predicated, solely, on traditional agricultural yield methods but requires the imaginative collaboration of many disciplines to solve. The integrative design solutions to the overall problem must come from our development of a comprehensive design science.

"Some may tend to underestimate the comprehensive nature of the problem, saying the people are thus starving and we have the land capacity to raise the food. This conception voiced by the theoretical specialist or casual observer is without benefit of logistic experience. It is not just a matter of raising food but getting food to people, anywhere from zero to 25,000 miles distant. And then it is not just a matter of getting food to people zero to 25,000 miles away -- it is a matter of getting it there at certain velocities; and it is not just a matter of getting it there at certain velocities, but it is a matter of getting it there on schedules in certain conditions, conditions of nourishing content, palatability and vital preservation. And even then it is not a matter of success concerning all the preceding conditions, for the dumping of a year's food supply in front of a helpless family huddled on the street-curb is but an unthinkable tragedy. The maggo appear in hours. And once again the continuing energy controls providing progressive freezes, heatings, etc. ,cannot be effected by refrigerators and stoves dumped in the street along with a year's tonnage of food. Obviously a world continuity of scientific-industrial controls resultant upon comprehensive and technical redesign is spelled-out as the irreducible minimum of solution."

1. Energy and Society. F. Cottrell, p. 167. (see bibliography)

Education and Communication

Education is the prime tool which increases unmeasurably man's freedom of both physical and psychic mobility.. Today through the phenomenal growth of our knowledge of history we are able, not only to mentally 'time travel', but also, with the successive incorporations of our educated intellectual wealth into mobile extensions via industrial technology, to swiftly transport our physical selves to all the historical sites which man has occupied in earth's history. Archaeology 'opens up yesterday as fast as today and tomorrow', and we seem in due ratios to explore as far back in our past as rapidly as we go forward into the future.

Such augmented experience is at the present time available only to the relative few. The more negative aspects of world education and communication are prominent in their combined graphic representation in this section. More than two fifths of the world's population is illiterate. Full access to the global communications network is not available for all.

Illiteracy is not in itself an evil,but only in that it denies one full participation in modern civilization. It is a constraint upon the individual's relative freedom. Rut, even, in the most highly industrialized countries, the task of educating the bulk of their populations to merely adequate standards remains immense. Recourse to traditional methods no longer suffices, and strenuous efforts are being made to incorporate the latest scientific findings in cybernetics and psychology and many other disciplines to find solutions which will match up to the magnitude of the task,

Whilst great knowledge and ingenuity are being put into research on the channels thro' which education is conveyed, little consideration has been given to what is conveyed in the communicated content. It is obvious that the magnitude of the task demands a most rigorous examination of 'what knowledge* and in which order, amount and forms it is to be conveyed in.

In our day,the bulk complexity and detail of our knowledge requires restructuring into assimilable wholes,and to be imparted even at the most elementary levels in terms of whole systems. We can no longer think in terms of single static entities - one thing, one situation, one problem - but only in terms of dynamic changing processes and series of events that interact complexly.

Traditional education proceeds from the most elementary local and separated out aspect to the complex whole - and therefore grows more 'difficult' as it advances. Such an approach may have sufficed when man's knowledge was limited and his set of experiences locally definable. In our present global civilization we require an educational approach which will embrace at the outset the most comprehensive review of fundamental 'generalized' principles, then, as these are progressively mastered, the approach should continue through their subdivision and application to the separate localized case. Having established this order from 'the whole to the particular' we need to take, then, all of the advantages afforded us by the latest communications developments through which the complex patternings and behaviours of universe may be brought within reach and made part of man's working everyday experience.

In terms of 'mass world education', which is the briefest statement of the problem, solutions may best be sought in the most highly advanced communications networks - cinema, television, etc, , and their combination with recent researches in psychology and cybernetics. The telephone system for example has already been used in most effective ways. Where verbal and non-verbal communication may operate together, those various established media have the-advantage of reaching large numbers of people at one time or may be flexibly adjusted to individual or small group requirements. The development of two-way television, almost realizable, will afford immediate 'feedback' which could make such mass and individually programmed education even more effective. We need a new eduational technology to integrate these various facets of work already accomplished and to develop swiftly a complete range of automated-education facilities[1].

' It is well to remember that the comprehensive world economics are going to force vast economic reforms of industries and nations which incidentally will require utter modernization of the educational processes in order to survive -- our educational processes are in fact the upcoming major world industry. '

As we effectively dis-employ man as a mechanical worker and pay him to return to his studies this will bring about profound changes in our concept of education itself. Education 'to earn a living' will become an anachronism. Education will develop in quite unprecedented ways.

Already in 'tourism', a resultant of the surplus wealth generated by the industrial equation, we may discern a developing ecological pattern of man which is part of this new educational process. Our schematic mapping of one year's such world around movement provides a succinct preview of the accelerated degree of man's mobility which will come out of the further increase in his shared wealth and re-investible time.

Men now come and go around the world with increasing frequency and range. **Local** man's per life average on foot may be reckoned in thousands of miles, With air travel, world man sweepout in a lifetime is in millions of miles. This is not only increase in speed, but is compounded with a comprehensive viewing of the earth and other men. Local, on foot, (or by horseback, or even railroad),travel experience was discontinuous. But the experience from the air is one of 'continuity' and finite comprehensibility of the earth, **and** the patterns of man upon it.

One may also observe that this extraordinary increase in individual **mobility.** is mainly that of urban man. It is the city man who travels - not the farmer. Urbanization need not then be viewed as a clogging up of the ecological network but just a present waystation phase of man's increasing deployment pattern.

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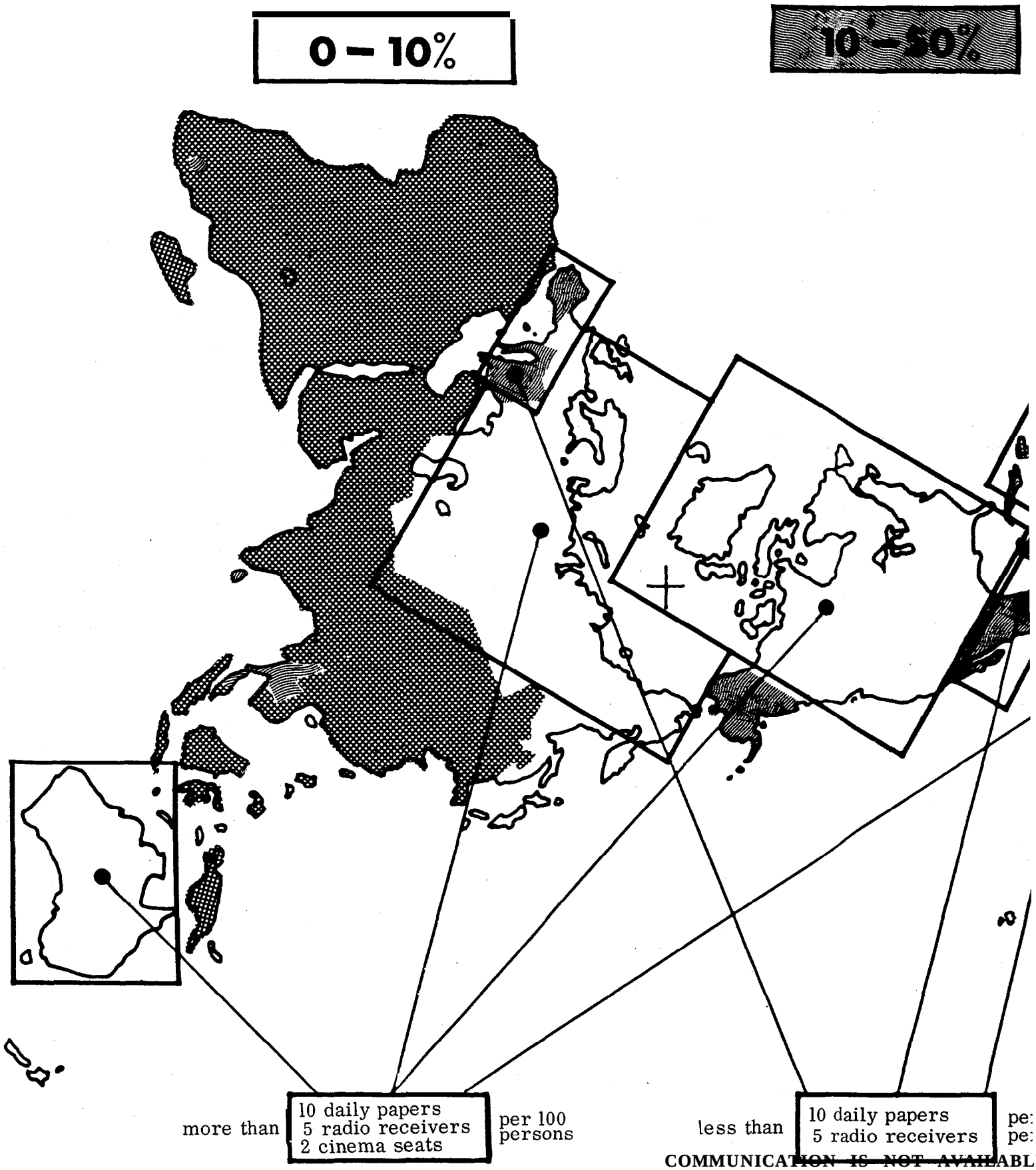
1. The display facility (Geoscope) suggested for the presentation of the world students' resource inventories would be a prototype for the further evolution of many such educational devices.

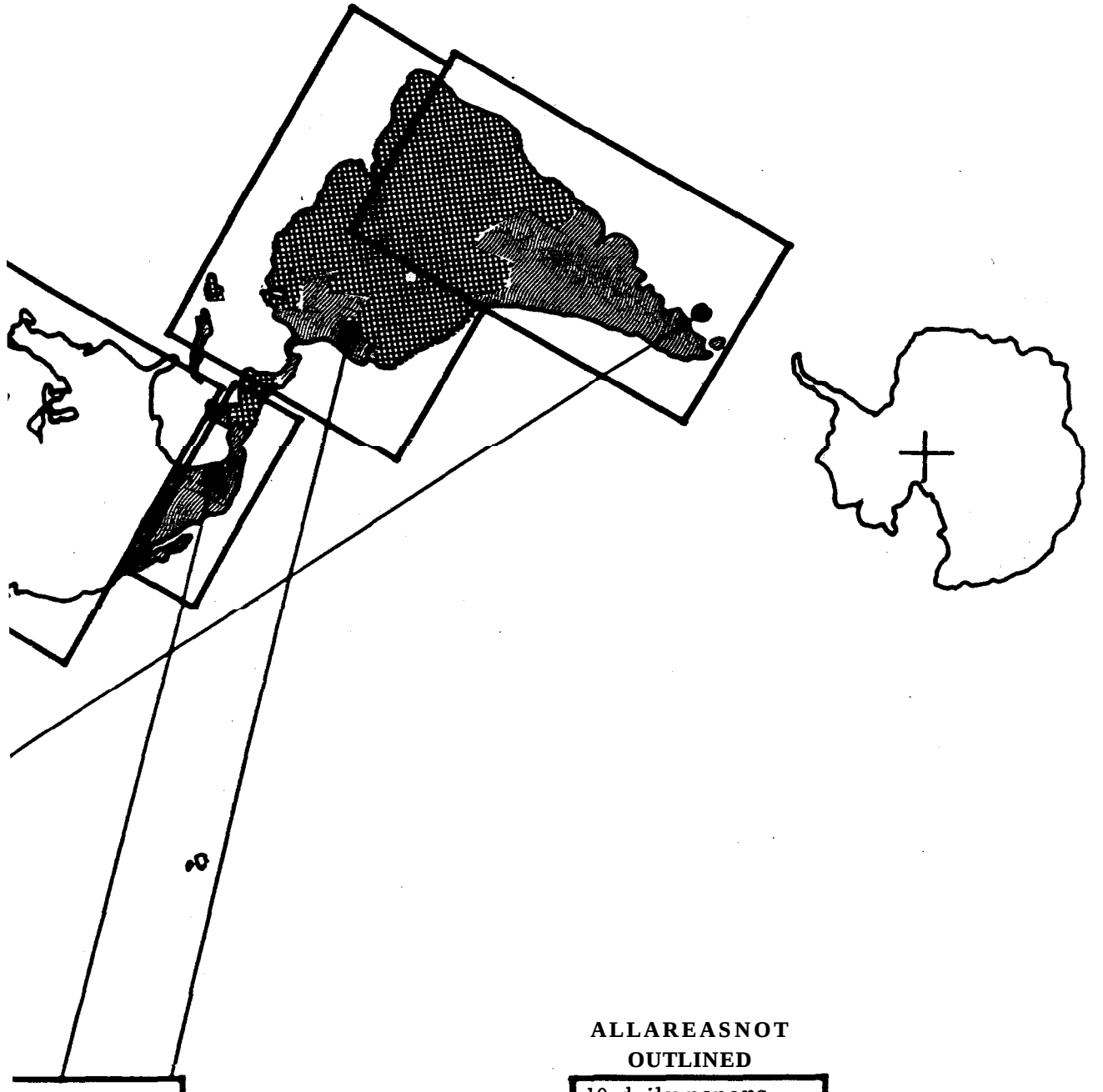
ONE HALF OF THE WORLD IS ILLIT



WORLD IS ILLITERATE

-50%

50%- up



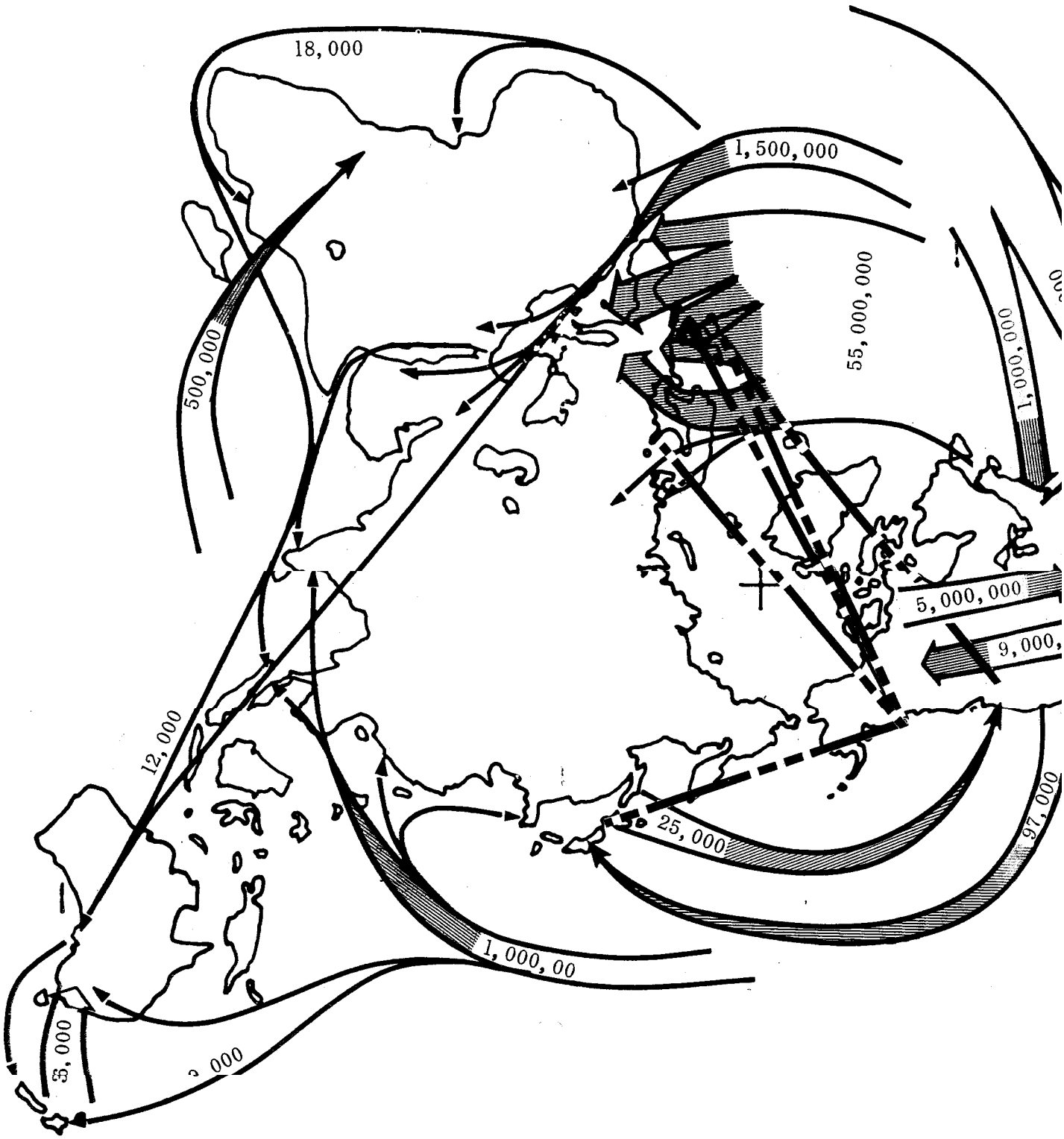
Ref. WORLD COMMUNICATIONS UNESCO

ily papers
lio receivers
per 100
persons

ALLAREASNOT
OUTLINED

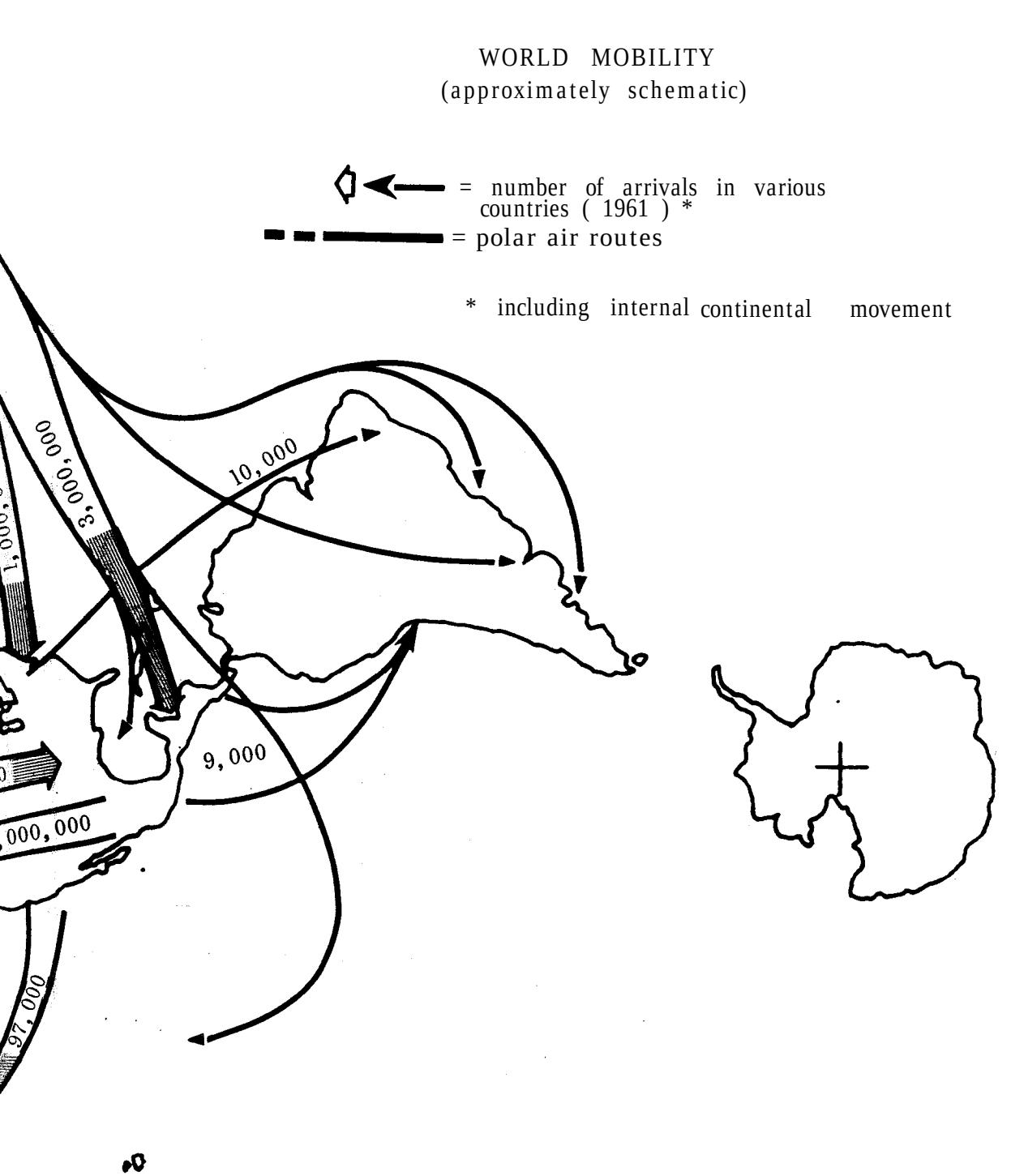
less than
10 daily papers
5 radio receivers
2 cinema seats
per 100
persons

NOT AVAILABLE TO ALL



Ref ; International Travel Statistics 1961.
International Union of Official Travel Organisations.

WORLD MOBILITY
(approximately schematic)



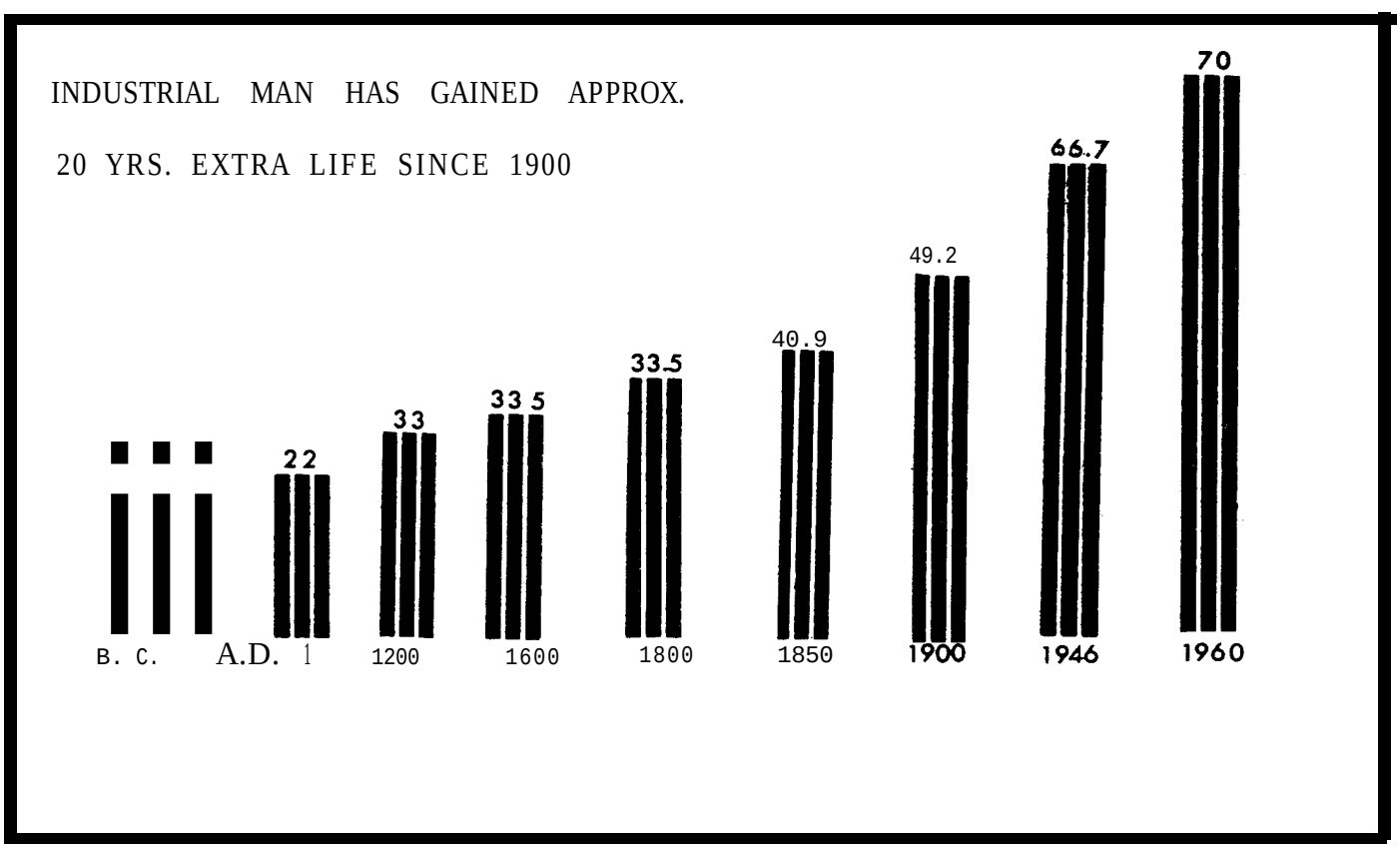
The evolving continuity of man's experience - with his extension into the past, his 'continuous' and simultaneous viewing of large areas of the earth from airplanes or as relayed from satellites - is directly related to his continuous organic renewals, and to the survival principles of the organism.

The trends in 'safety miles' travelled by auto and air show an enormous increase in achieving the required speeds and mobility - under safer and safer conditions.

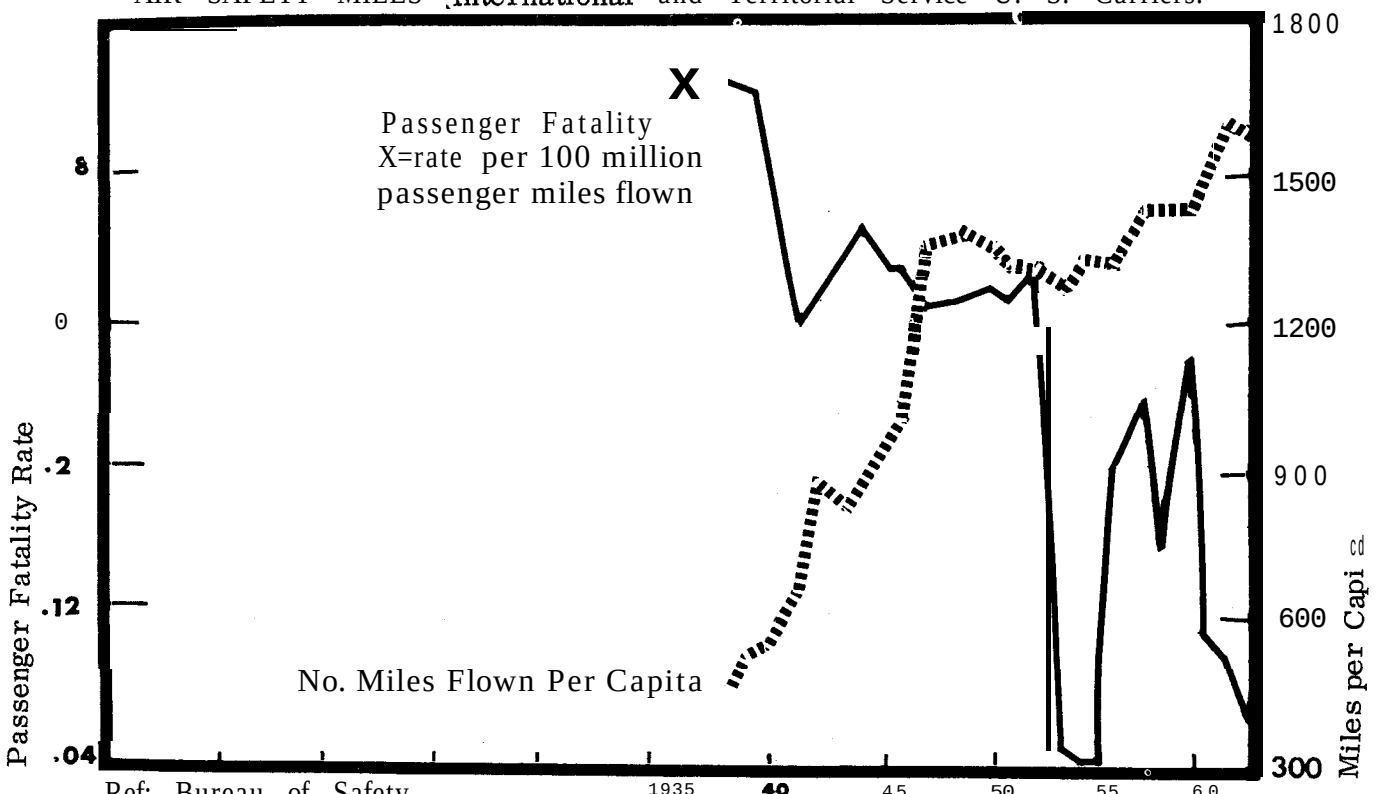
Man demonstrates, in these chartings of his safer travel and dramatic gains over certain diseases, an inherent success mechanism. This forward continuous quality may also be relatively predicated in terms of the individual man and his gain in life years expectancy. The ways in which man has begun to use his increasing knowledge of his internal metabolics repair, restore and replace internal fluids and even organs as required. The world blood transfusion services now span a great area of the globe and handle many thousands of units of blood and plasma annually. Organic transplants of certain types like eye corneas, are coming gradually into standard inventory items. Artificial valves, tubes, clips, etc., have been part of man's internal replacement service for some time, and his various prosthetic attachments are approaching the relative complexity of natural limb capabilities.

One of the most exciting areas of this bio-technical development lies in the scientific extension and augmentation of human brain power via subtle interface linkage with computer systems. Augmentation is already available in using the computer, but the developing systems, referred to envisage large network hook-ups to main or individual centers by individual portable prosthetic type attachments.

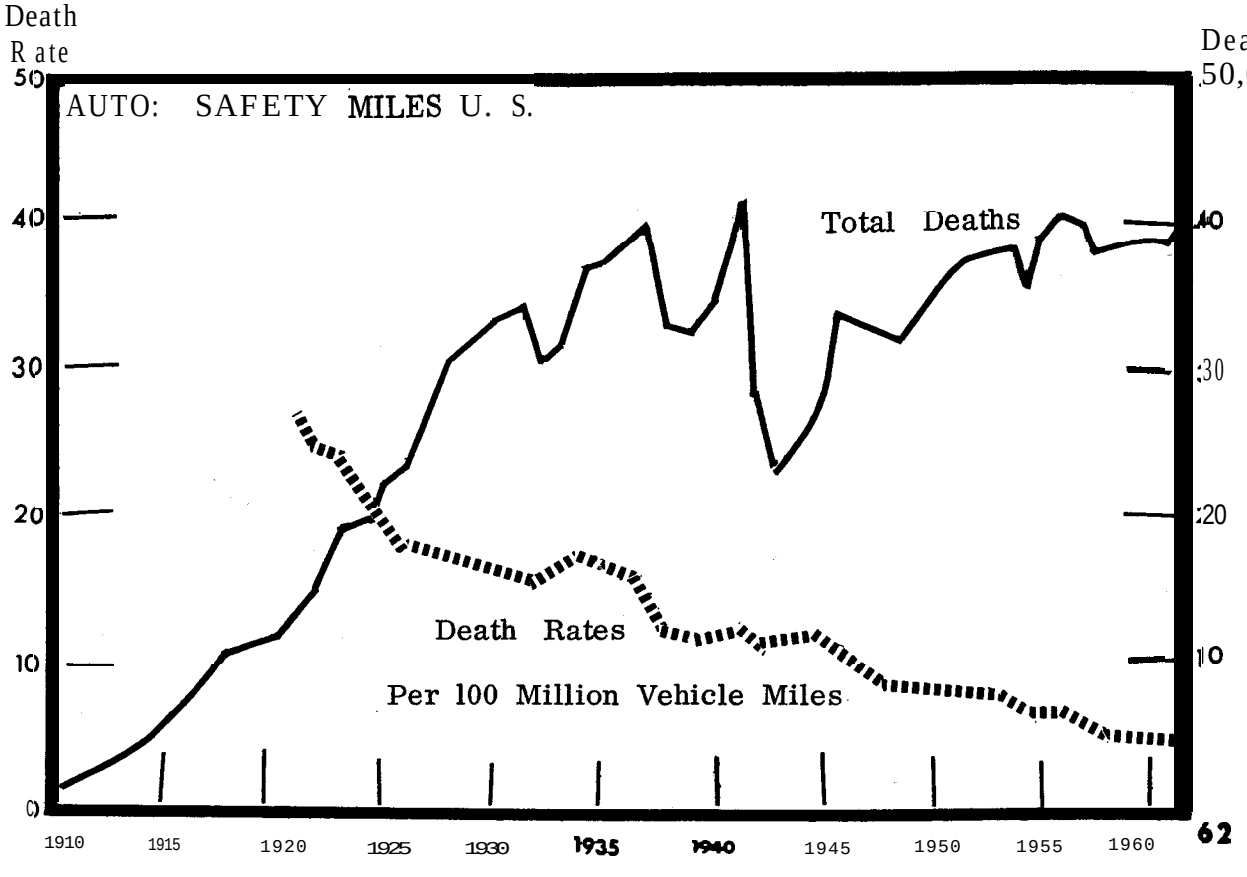
LIFE EXPECTANCY



AIR SAFETY MILES (International and Territorial Service U. S. Carriers.

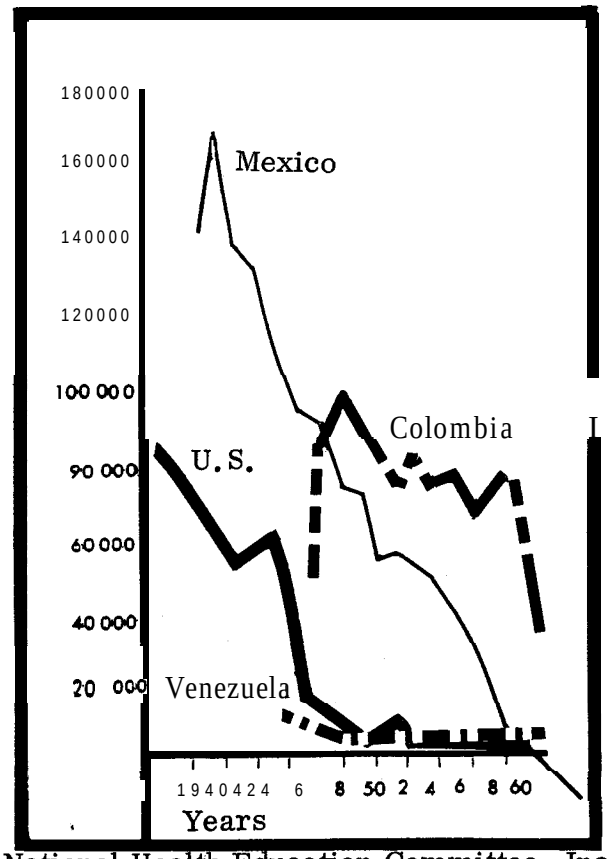


Ref: Bureau of Safety
Civil Aeronautics Board 1963



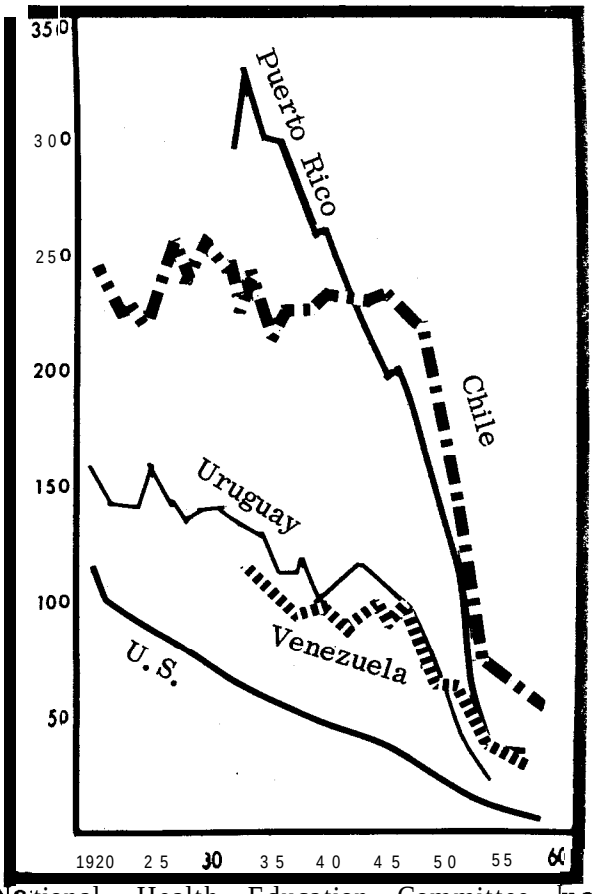
Ref:National Safety Council (U. S.)
Accident Facts 1963 Edition,

MALARIA: Number of Cases



National Health Education Committee, Inc.

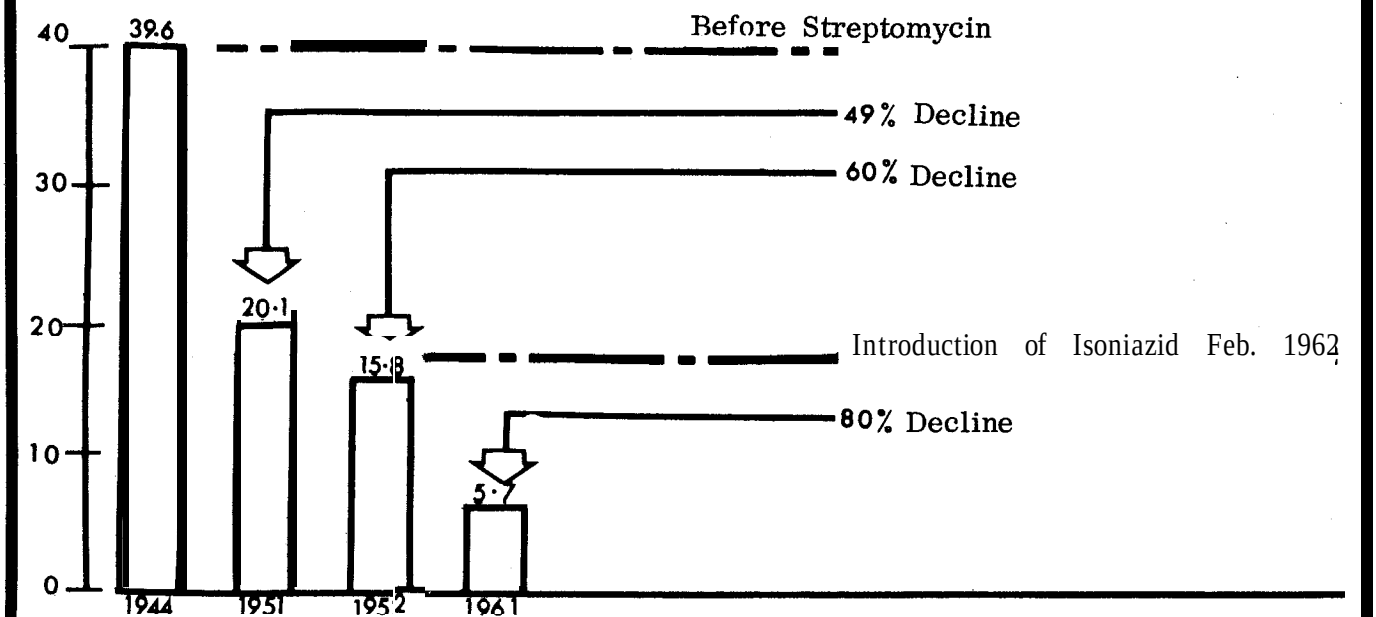
TUBERCULOSIS
Deaths per 100,000 Population



National Health Education Committee, Inc.

DECLINE IN TUBERCULOSIS DEATH RATE

U. S.



National Division of Vital Statistics

Appendix A

To: The World Architectural Students

From: R. Buckminster Fuller

Subject: NEW FORMS VS. REFORMS

In the 1920's with but little open country highway mileage in operation, automobile accidents were concentrated and frequently occurred within our urban and suburban presence. Witnessing a number of accidents, I observed that warning signs later grew- up along the roads leading to danger points and that more traffic and motorcycle police were put on duty. The authorities tried to cure the malady by reforming the motorists. A relatively few special individual drivers with much experience, steady temperament, good coordination and natural tendency to anticipate and understand the psychology of others emerged as "good" and approximately accident-free drivers. Many others were accident prone.

In lieu of the after-the-fact curative reform, trending to highly specialized individual offender case histories, my philosophy urged the anticipatory avoidance of the accident potentials through invention of generalized highway dividers, grade separaters, clover leafing and adequately banked curves and automatic traffic control stop-lighting systems. I saw no reason why the problem shouldn't be solved by preventative design rather than attempted reforms. My resolve: Reshape environment; don't try to reshape man.

The early response to my philosophy was that it would cost too much and was too long distant, would require too much science and engineering, would make life too mechanical and would abrogate states' rights. A half century has shown me that we have now undertaken to do the costly design anyway after having experienced the far more costly ten million traffic deaths (which outnumber the potential hydrogen bomb kill on the New York target) as well as the vast billions of dollars worth of property damage and the incalculable pain, bereavement and shattered life ramifications of those lethal traffic events.

Juvenile delinquency is a problem that will never yield permanently to good willed social or even to hard political reforms invoking police state tactics. J. D. is a consequence of ecological inadequacies. It is entirely a design problem. Inadequate space and facilities for fundamental growth and experience needs of youth, characterising city dwelling in general in both slum and high-cqst multiple dwelling areas, are directly responsible both for youth's subconscious and conscious awareness of the inadequacy and its inexcusable incompatibility with nuclear fission, moon rocketing, polar submarine passage, as well as general scientific and industry capability. It is an inescapable contempt for the social incompetence that tolerates its continuance

that is only satisfied by throwing a stone through any window which seems symbolic of the failure of the adults to organize the total potentials to solve first things first--first being how to produce the good life for all and not how to destroy all life in one "retaliatory warhead exchange.

The consequence of expediency is usually that we pay twice as much in the end as it would cost to do it the right way in the beginning.

Within the grand strategy of anticipatory problem solving to be accomplished exclusively through design transformations of human ecology's physical environment apparatus, the design strategems range from powerful to subtle. For instance, instead of attempting to push the bow of an ocean liner from one side to the other in order to steer it (as we do the front ends of automobiles, as well as of social trend fronts) inasmuch as the great seas also try to push the bows to one side of the other thus tending to throw the ship out of control, the naval architect must design in such a way that the ship's course will not tend to be diverted by heavy seas yet will be steerable. To do this he designs a ship's hull with the hinge or pivot point of the ship occurring forwardly under the step of the bow. This makes a long lever arm aft and a very short lever arm forward of the pivot and the long lever over-powers the short one as in a weathervane "ship". Thus the naval architect makes the stern of the ship (rather than the bow) swing to one side or the other of the course. The course tends to be held steadily by the bow. The stern tries to follow the bow in a straight course. The keel then makes the stern follow the bow when the ship is in motion. In order to change course, the stern is deliberately swung to one side or the other. This is done by the rudder at the stern which is so small as to be easily manipulated. The rudder by making a small drag angle creates a partial vacuum on the side of the rudder opposite to that of the direction in which the rudder is moved. This partial vacuum starts to pull the stern of the boat which causes a much larger partial vacuum to build up on the stern quarter of the ship on the side toward which the stern swings as the ship moves through the water in this askew attitude. This vacuum is built up for the same reason that the horizontal askew attitude of a wing-foil in motion through the air creates the lifting vacuum on its cambered or top surface. The reason is that it is a longer distance around the cambered askew side for the parted water to reach, as suddenly displaced by the ship's motion, which makes the longer-way-reach tense the, air interspersed, water molecules, creating a partial vacuum. So powerful is this partial-vacuum, or negative pressure, chain-reaction buildup that it can for instance suck-pull the 30-knot-speeding hull of the 85,000-ton, Empire State Building sized, Queen Mary into a new angle in respect to the directionally fixed momentum of her bow-pivot center, which thus hinges the Queen Mary into a new course attitude, which is fixed when the rudder is returned past "midship" to "meet her" or break the vacuum build-up and then returned to midship position.

This principle of creating vacuums with minimum effort that will self-regenerate to build up large vacuums to govern very large, pattern transforming work is even more dramatically emphasized in the case of the giant jet airliners -where, literally, postage stamp size trin-tabs in the trailing edges of the large vertical and horizontal ruddering surfaces are all that are used by the automatic-gyro-pilot servo-mechanisms to keep these hundred-ton sky giants hurtling along

at 600 miles per hour on accurate multi-dimensional course despite invisible atmospheric turbulences far greater in size and velocity magnitude than those of the water ocean.

My philosophy takes primary heed of the fact that all in universe is in constant transformative complex motion and all transform in patterns of least resistance. Therefore, philosophically it became evident that by subtly designed, "trim-tab" size inventions we could, with least physical effort, control the least resistant directions of various fundamental transformings. This could be done by devices which would so control the angle and frequency occurrences of little vacuums or tensions that they would automatically induce large vacuums and tensions which could cause man's ecological patterning to evolve in preferred patterns. Designs could also detect and discretely vitiate specific subtle vacuums chain-reacting into larger vacuums and thereby holding certain transforming systems on socially deleterious courses.

How much more powerful is the miniscule ship's rudder when in good order than a squadron of ships trying to maneuver a rudderless ship in a heaving sea by attempting to push the rudderless one with their plunging bows in preferred directions as do tugs maneuver a big ship in still water when the ship is moving too slowly to have steerage-way! Also how futile are shouted words of warning and exhortation in such situations! Only the rudder and the brain that directs the rudder are effective. No wonder Norbert Weiner included the Greek name for rudder in coining his "Cybernetics" to identify the newly emergent computer's feed-back system science. No wonder the early Egyptian and Greek shipmasters stood in the stern of their ships, facing forwardly alongside the single oar steering slave as the crew of backwards facing slaves tensed at the banks of vacuum fulcrumed oars. Here is the picture of society straining at its slavishly accepted work, backing up, blindly into its future as an, often nearsighted, excursion captain cons the course.

My philosophy also takes heed of the, approximately unlimited, ratio of length to girth of tensional controls which always tend **to pull true vs. the very** limitedlength-girth ratio of pushing devices which when pushed tend to bend and break.

Philosophically it is clear that trim-tabs occur in the trailing edges of trailing devices--in the tail end of tail-end events--at the stern of the ship as the last event and not at the bow as the first event. The bow is important to keep the ship on a chosen course but the stern rudder puts and holds it on the chosen courses. The real steering takes place when the non-scientifically informed observer thinks everything is "all over. " But that final steering has to be done from "on board. ' Just "having the last word" from away back in the wake of the ship is futile. Scientists have often said that the most important part of their greater discoveries occurred at the outset, in the proper formulation of the project's objectives, forgetting that those enlightened formulations were really the after-image inducements of tail-end events of earlier and seeming failures of experimentation.

My philosophy also concentrates upon synergy, the behavior of whole systems unpredicted by the behavior of the system's components, taken singly, or in addition, as for instance chrome-nickel-steel whose tensile strength is 50 percent greater than the sum of the tensile strengths of all its component metals. Synergy is readily explained by mathematics.

It was in the synergetic combination of such trim-tab and tensional type thinking regarding intellectual advantage over physical pattern dynamics that my philosophy emerged in 1927 as a set of generalized principles governing objective design formulations. I saw, as the tail-end event of one of my own private catastrophies, that the seemingly adverse events of history could, always be, and sometimes have been, turned to fundamental advantage --even by physically miniscule individual man, despite the formidability of the era of the massive governments, corporations and promotional or protectional organizations representing all manner of debilitating biases. In 1927 I deliberately entered the "trim-tab lab". Thirty-six years later with approximately 2000 environment controlling structures air delivered and installed in 40 countries around the earth as well as in both Arctic and Antarctic regions, I have the following exploratory events to report.

The Union International des Architects known as the U. I. A. is the only world organization of architects. Its membership includes 60 countries on both sides of the political curtains. Two thousand architects attended its last World Congress held in London, England, in 1961. The Executive Committee of the U. I. A. has officially accepted (Sept. 1962) my proposal (July 1961) that the world's architectural schools undertake a ten-year, five increments exploration and design, purporting the reuse of the world's intellectual and physical resources in such a scientifically designed manner that 100 percent instead of 44 percent of humanity may enjoy not only a high standard of living, but freedom of intellectual and physical initiative as well as educational advantage and travel embracing the whole earth.

I have had a third of a century experience in harvesting such world data and in inventorying the world trendings to be implemented by such a one-world-town anticipatory de sign science. As technical consultant to Fortune Magazine, 1938-40 (earlier, as the assistant to the Director of Research, Phelps, Dodge Corporation, 1936-1938; and later as Head Mechanical Engineer of the U.S. Board of Economic Warfare; and as assistant Deputy Director of the U.S. Foreign Economic Adminsitration, 1942-1944); I have had experience, in inventorying world economic resources as manifest in the 10th Anniversary issue of Fortune dedicated to "U. S, A., and the World, ' a quantitative inventory of World Industrialization at the outset of World War II.

Organization of the coming ten-year world human ecology program, in comprehensive anticipatory design science, to be promulgated by the only world organization of professional architects becomes a logical fulfillment of my experience.

In recent times the term Systems Engineering has developed to cover large and complex engineering design integrations--such as those of large aircraft missile delivery systems in contradistinction to non-manned missile delivery systems. There are even larger complex design integrations such as those of the "National Defense System. ' Design of the world-around General Motors organization, now netting $1,500,000,000 annual profit, after payment of taxes, is in fact another such corn-prehensive design undertaking, though it has been popularly known only as a business venture. The early, original, large business venture organizations such as the East India or Hudson's Bay Trading Companies and the prototype industrial corporations

such as the Ford Motor Company should be thought of as special cases of generalized systems design. Few men have been admitted to the conceptual councils of such enterprise. The vast majority of educated men are educated to be specialists, ergo, cogs in the wheels of these vastly designed systems, the blueprints for which the master designers "micro filmed" into their brains while burning the original drawings lest their competitors, active or potential, learn of their secret and comprehensive anticipatory designs. Funding and controlling the educational institution prototypes, the old economic master-conceivers never permitted comprehensive design science to be fostered except in their Naval Academies where their first line of enterprise defense was to be maintained. They created law schools and business adminstration and engineering schools in order to acquire specialized lieutenants. There is now a strong intuition of democratic society that comprehensivity must be regained wherefore general studies programs are emerging in strength. At the December 1962 annual meeting of the American Association for the Advancement of Science, a research paper was read which showed that biological species and nations that have become extinct did so because of their becoming over-specialized. It has now developed that the prime distinctions between humans and computers as intelligence machines is that the computers can easily excel as specialists whereas the unique characteristic of the human intellect which may never be approached is that of the universe-long complexity of feed-back comprehensivity of introduced variables, a comprehensivity that could only be matched by a complex computer which had been building up its regeneratively introduced variable strands braiding for a period of several billion earth years. This temporary human advantage, of a few billion years lead,is about to be widely discovered and will be one of the prime strategic considerations of man's meager conscious contribution to forward events' of universal evolution.

My early experiences at the Naval Academy and in the regular Navy under the First World War conditions of accelerated emergency enlightenment of task force officers brought me into intimate experience with the formulation of comprehensive anticipatory design science as neatly but vastly packaged up in the concept, Navy. As personal aide for secret information to the U.S. Admiral commanding the United States Cruiser and Transport Force which with a fleet of 130 ships successfully carried America's million men to Europe and back between 1917 and 1919, I learned that Navies and their fully realized strategic capabilities required from a half century to a full century of anticipatory perspective. They required generations to build to world supremacy. The official Navy designing geniuses were combined scientist-artist-lawyer-merchant-venturers who were not alone concerned with Ships of the Line, plus only the supporting train, and a world-around pattern of naval stations and shipyards. They were also concerned with designing and building the total industrial support capability of the nation's swiftly evolving science and technology. U. S. Steel, General Motors, E. I. DuPont de Niemours, General Electric and the American Telephone and Telegraph Companies didn't just pop up as happenstance mushrooms after a rain, nor did they develop independently. They together with the United States Navy and the British Navy and all British Imperial this and thats "Limited" were all of one piece in the brilliantly conceived brains of a very few men amongst whom one of the few that we know of was J. P. Morgan. So powerful were these men that such declarations as that which I have just made never occurred in their day. Few comprehended their existence. Those few who caught on were either made partners or went "busted. "

These old master designers and operators have been dead since the great 1929 crash. And while the special case secrets died with them the generalized principles governing systems design live on.

Since 1929, in the era of increasing specialization, the comprehensivist problems have been left largely unattended, but here and there, and no longer on a world basis, have been locally administered by the fortuitous emergence in our society of business operating, but not conceiving genuises or of political dictators, who took over government operation of the amalgamated, enterprise system packages, lying fallow within their national reach.

Just as the doctors, freeing themselves of client self-diagnosis and command, long ago seized the initiative in dealing with the internal organics of man as a total integrated science, I have forseen, for one-third of a century, that the opportunity existed for a new professional architectural scientist to seize the initiative, independent of client prerogatives, in dealing anticipatorily with the external organics of industrial man. I am confident that the generalized principle7 governing comprehensive anticipatory design, manifest in each and all of the typical "special cases" of the comprehensive systems designs which I have cited, have now become scientifically extractable as describable pattern further reducible to mathematical, physical and chemical formulae.

The' Director of the U. S. Marine Corps Aviation Logistics made broad special case application of my generalized formulae in the realistic 1954-1956 analysis and found them apparently sound. I myself for over one-third of a century have been testing my generalized formulae as extracted from my comprehensive naval and commercial and industrial training and as applied to prognostication of world patterning trends and have had sufficient, well documented, success to warrant this new 1963 stage of their exploratory application to the U. I. A. ten-year world designing program.

The U.S. World War II strategy called for invasion of Europe from North Africa. This meant a large U.S. troop and-logistical support route via Brazil to Af rica. Under these circumstances, Brazil was in a position to demand much reciprocity. In 1943 President Vargas of Brazil asked President Franklin Roosevelt for main items and amongst them for a comprehensive digest of the experiences of U. S. Industrial corporation engineers in Russia, between 1926-1938, during Russia's contracting with leading U. S. industrial corporations for the furnishing of machinery and building and installation and organization of prototype factories in all the prime categories of industrialization. Vargas also asked that the experience digest be analyzed and integrated into a design system which might disclose the essential planning logic of Russia's comprehensive acquisition of total industrialization in the shortest possible time. What did Russia have and what did she have to acquire from outside of Russia to get started? What were steps of "first-things-first"? What were the arguments that determined the sequence of stages of acquisition of full industrializatior I received this assignment and' interviewed most of the U. S. engineers, and industrial executives as well, who had had the Russian contract experiences. These were the men who actually supervised the Russian building and tooling up of the prototype

factories in the full array of prime industrial categories. As expected, they had all had interesting discussions with the Russians regarding industrial planning. I made and wrote the digest of the experiences, as well as the analysis and breakdown into a disclosed Russian master planning priorities scheme, and the prime arguments supporting the decisions. Also in response to Vargas' further request of Roosevelt, I generalized the planning principles manifest in the special Russian case of fundamental planning and reapplied the generalized principles to the special case planning of Brazil's proposed industrialization. Several of the most important of my proposals for Brazil's industrialization have since been adopted in Brazil, but they have not as yet instituted organized planning as did Russia. My report made clear that this would never be possible in Brazil alone.

When I had completed that task and it had gone on its official way, every item in it had been advocated by one or another prominent U. S. industrial engineering executive. It was a plan of which U. S. industry's engineers approved.

It became clear to me as a student of large, generalized systems design science that industrialization is a vast external metabolic organism of Man and a fundamental and orderly counterpart--function for function--of the internal metabolic organism of Man. It was clear that men's internal organism was not designed by man and simply occurred without man's important knowledge of its design or development of maintenance. It occurred to me that while individual men--as inventor mechanics, inventor scientists, inventor managers-- had perceived functions that could be transferred from human organism work to inanimate machinery work, that nonetheless the principles were inherent in nature and not truly invented by man. Therefore, it could be said that out of a myriad of individual perceivings by individual human inventors which externalized man' s internal and integral functions as inanimate mechanics that they were inadvertently all integrating synergetically as a total industrial world encircling network organism that I called "continuous man. " The latter I saw was inherently a self-correcting, nervous intelligence, feedback system, and inherently regenerative, and inherently self-augmentative, as it inhibited greater and greater magnitudes of cosmic energy which the physicists assert may be neither created nor lost and that men simply discovered means of shunting hitherto untapped cosmic energy which the physicists assert may be neither created nor lost and that men simply discovered means of shunting hitherto untapped cosmic energy transformation patterns into man-devised circuits and channels to do more and more work in the ever more effectively integrating total industrial organism. Continuous man was finding more cosmic "berries" much as man had found berries on earth to eat and water to drink. Industry, like man, needed its energy food.

It became clear that not only could I apply the principles of industrial gestation growth to Brazil but that I could also with equal theoretical facility consider withdrawing industrialization from already industrialized or partially industrialized political entity economies. I found that if I withdrew industrialization from both Russia and the U.S. A. and left Russia its socialism and left U.S. A. its capitalism, both of which were invented pre-industrially as schemes for survival by or exploitation of agricultural-metabolics wealth incrementations, that Russia and the U. S. A. bereft of the industrialization would each lose about 100 million population by starvation to

death within ten years, which is about the scale of devastation that would occur with atomic bombing, not by direct hit, but by the same loss of the industrialization. It was clear to me that it was industrialization (which is an entirely new phase of metabolic organism and nervous system feedback, growth on earth, in extension of man's integral metabolic and feedback nervous organism) that was entirely responsible for the last century's extraordinary advance of the physical survival success 'of man on earth and his fabulous transformation from a local fifty-mile diameter average lifetime ecological domain to a world around and solar system lifetime ecological domain. Man's memory had grown from a single generation span to a half-million-year industrial relay system range.

I saw that ignorance, and the inherent, local-experience biases of ignorance, self-persuaded the occupants of the local, political, ephemeral states, first blessed by industrialization, that their special case political preference in regard to the mutually obsolete agricultural era's socialism and capitalism had been exclusively responsible for the twentieth century burst in human prosperity. I saw that U. S. A. 's pseudo capitalism (for it no longer existed as a prime- industrial enterprise initiative - that function having been taken over by the military defense establishments of all major nations) was convinced that capitalism had blessed the world with industrialization and should therefore prevail around the earth as the most efficient economic wealth propagating system.

I saw that Russia aspired to bless the world with absolute communism as the consequence of their earnest assumption of the validity of communism seemingly inferred by Russia's half-century rise from abject poverty and illiteracy to co-supremacy in world military might. Russia of course acquired industrialization, not under communistic rule, but under the absolute dictatorship of Stalin who was eager for his side to win and went outside and bought industrialization with gold, fortuitously found in Russia at that time, from idle U. S. A. and western Europe industrial corporations bereft in 1929 of their old capitalist masters. The historical fact is that industialization, as the external metabolic processing of man, behaves just as the internal metabolic processing of man, from which internal functioning it directly derives, and as with the internal physical organism of Man it serves any color, and any political system, individual, good, bad, wise or mad, with equal metabolic efficiency. Man as brain knows as yet fundamentally little regarding the complex synergisms manifest at various magnitudes of universal metabolic processes, serviced so effectively with integral and mostly sub-self-conscious, intelligence feedback systems.

Both major political world "sides" and all secondary political states when entering into the next Olympic games will use the same sports equipment or tools--all the pole vaulters will vault much higher than ever before due to the new fibre-glass plastic poles whose increase in strength performance per pound is an industrial intelligence metabolic increment. None of the nations may claim that their pole vaulting improvement is a consequence of the superiority either of socialism or capitalism, though I am sure both Pravda and Chicago Tribune will argue editorially that there is a distinct connection.

Both sides are now prospering by vaulting with industrialization's integrated tool complexes. Both sides have now been able to vault over the moon with the pole of

integrated industrialization and with a galaxy of other industrial lever-poles to "pry loose" an increasingly satisfactory physical survival from the invisible principles governing universal evolution,

It became apparent to me long ago that if the principles of industrialization as the external metabolic organisms of man, serviced by an intelligence feedback system were to be professionally fostered by comprehensive, anticipatory, design scientists as are the internal metabolics and nervous organisms of man fostered comprehensively and anticipatorily by medical science, that we would swiftly emerge from the lethal dilemmas that Man now finds himself besieged with as biases of political ignorance, and Man's innocence in general, allow him to lunge and push blindly into dan gerous psychological conditions, inflamed by a general world news-drunkenness.

Quite clearly our U. I. A. ten-year student undertaking will be looked at, if looked at at all, as an innocuous diversion of an inconsequential profession of interior and exterior house and building decorators. This will be all to the good. It will mean that the project will be left alone to do its hard work. That is excellent. It may even receive foundation or even federal, cultural category, support funds to speed it, for the political world is intuitively aware that culture from time to time leads the way unexpectedly over high mountain passes through the artist-scientist's inherent political transcendentalism. Trim-tabs and miniscule, precessional retro-rockets can maintain altitude courses with low physical effort, if the thinking manifest in tools is comprehensively adequate and uninhibited.

Faithfully yours,

R. Buckminster Fuller

Appendix B:

Forward Procedure

The main forward procedure for schools participating in the first two year phase of the world architectural schools' program has been outlined in the proposal to the I. U. A. Executive, by R. Buckminster Fuller.

Individual schools will obviously develop those particular approaches which are most suitable to their own curricular and other requirements. The World Resources Inventory project at S.I.U. will be pleased to assist in any way with information relative to this report, on the procedures adopted in its compilation -- or in any other way which may forward the undertaking. It may be suggested that a monthly compilation of local area data could be sent to the above office. This could then be processed and redistributed to various other operating groups as required., In this way, information not locally available to any one group could be readily obtained.

A brief outline of the computer program used in processing certain parts of the report data follows in this section. Per capita calculation was used as far as possible in most analyses. The main manual conversion factors used are also listed.

Postal address of this project:

World 'Resources Inventory
Southern Illinois University
715A South University Ave.
Carbondale, Illinois, USA

Telephone: 457-2149
Area Code 618

DATA CONVERSION AND PER CAPITIZING PROGRAM REPORT

Electronic computers are designed to respond to special command codes called "machine languages". These languages are numeric and completely alien to the spoken languages used by man. In communicating with these machines, computing analysts have developed intermediate languages which may be translated by the machines into their own language. Such a language is FORTRAN (FORmula TRANslating) system in which the accompanying program is written.

First some brief comments about various statements in the program. READ, GO TO,DO, PUNCH, AND END mean exactly what they do in English. A FORMAT statement gives the form in which a statement is to be read or punched on cards. Arithmetical notation is as in normal usage except that * replaces X for multiplication. For ease in handling the figures, all data and conversion factors are written in scientific notation of the form l.OOOOE+04 for 10,000.

The program is written for the IBM 1620 computer and utilizes the four sense switches on the console. The program works as follows. First it tells the machine to read the number of tables- to be stored (maximum;8). The- first table must be the conversion table (see example below). Then the machine is told to read in the tables, each preceeded by the number of entries in the table. Then the machine is told to print out instructions; i. e., which switches to turn on to use each table. Next the machine must read in the raw data cards (see attached example A) and perform the operations listed below. The sequence of operations is shown in the accompanying flow chart.

1. Check the sense switches to see which tables are to be used.

2. If switch one is on, the unit code is checked to see if it is alphabetic or numeric.

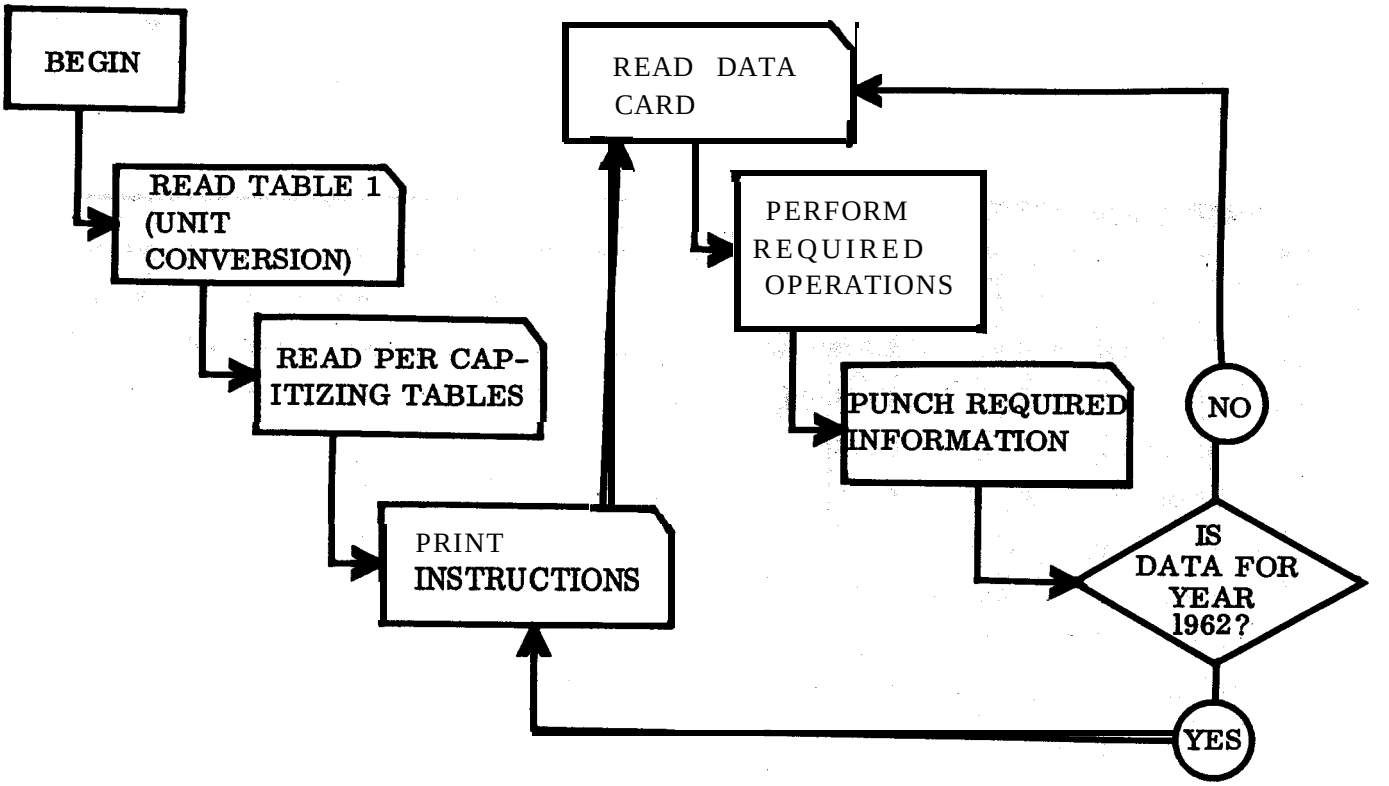
3. If the code is alphabetic this means the data is already in metric units and the computer picks out the correct population figure and per capitizes the data.

4. If the unit code is numeric, the computer reads the code, picks out the corresponding conversion factor and converts the data to metric units and does the per capitization.

5. The computer then punches the data out on the final data card. (see attached example B).

These final data cards were used experimentally in another program to provide a graphic representation of the per capitized data (see example C). However this program is' still in the experimental stage and has not been included in this report.

DATA CON-VERSION AND PER CAPITIZING PROGRAM FLOW CHART.

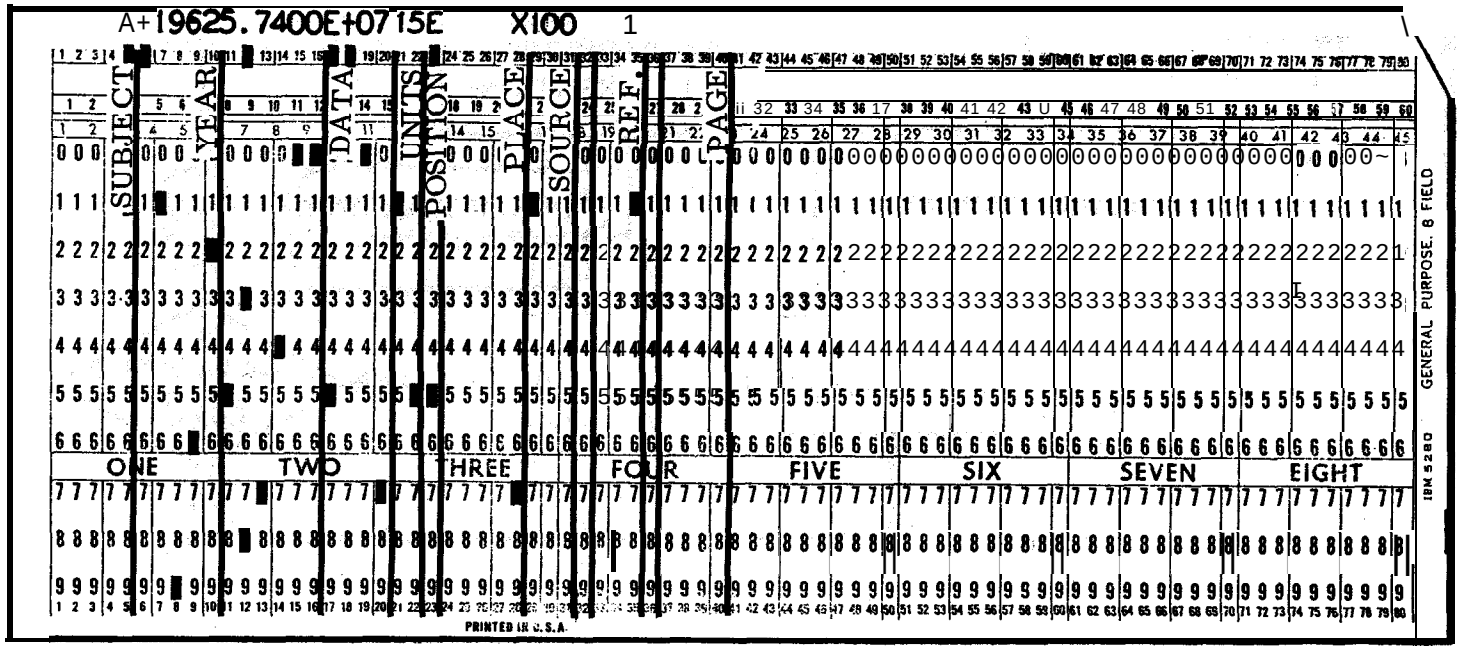


CONVERSION FACTORS

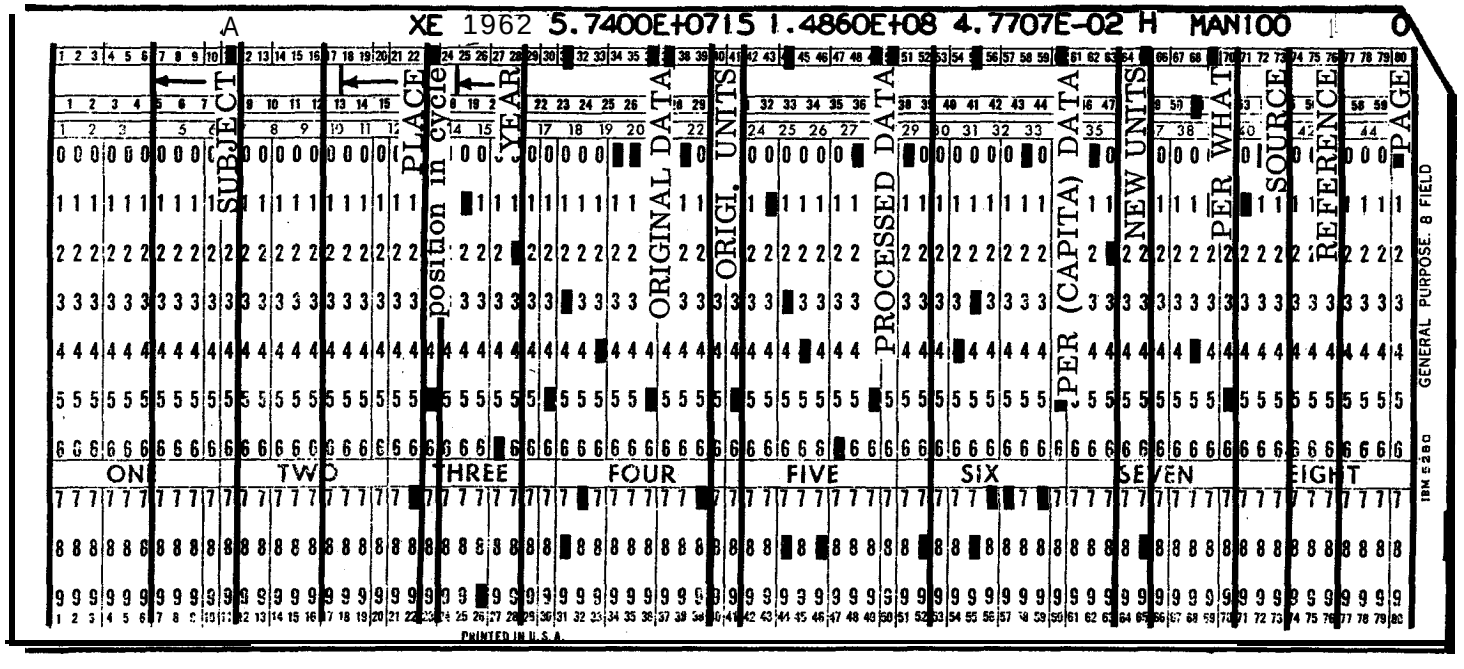
Table One in plain language.

CODE	MULTIPLY	BY	TO OBTAIN	CODE
0	NUMBER	1. 0000E+00	NUMBER	0
1	MILES	1.6090E+OO	KILOMETERS	A
2	FEET	3.0180E-04	KILOMETERS	A
3	POUNDS	4.53503-04	METRIC TONS	C
4	OUNCES	2.83403-05	METRIC TON'S	C
5	SHORT TONS	9.0720E-01	METRIC TONS	C
6	BTUS	2.92803-04	KILOWATT-HOURS	D
7	HORSEPOWER	7.45.703-01	K I L O W A T T S *	E
8	BARRELS (CEMENT)	1.7050E-01	METRIC TONS	C
9	CUBIC FEET	2.83203-02	CUBIC METERS	G
10	FOOT-POUNDS	3.76603-07	KILOWATT-HOURS	D
11	LONG TONS	1.0160E+00	METRIC TONS	C
12	ACRES	4.04603-03	SQ. KILOMETERS	H
13	U.S. GALLONS	3.7850~-03	KILOLITERS	F
14	IMP. GALLONS	4.54603-03	KILOLITERS	F
15	SQUARE MILES	i. 58903+00	SQ. KILOMETERS	H
16	WHEAT BUSHELS	2.57203-02	METRIC TONS	C
17	FINE OUNCES	3.21503-05	METRIC TONS	C
18	U.S. BALES	2.2680E-01	METRIC TONS	C
19	BARRELS (OIL)	1.5890E-01	KILOLITERS	F

EXAMPLE "A"



EXAMPLE "B"



*position in cycle - production, consumption, etc.

```
      REAL' 30,N
   30 FORMAT(I2)
      READ 31,MM
      I=1
      DO 7 K=1,MM
    7 READ 48,IB(I,K),XP(I,K)
   48 FORMAT(9X,A2,30X,E11.4)
      DO 3 I=2,N
      READ 31,MMM
      DO 3 K=1,MMM
    3 READ32,IB(I,K),XP(I,K)
      PRINT 60
   60 FORMAT(33HTURN ON SW.1 F O R TABLE 1(UNITS))
      PRINT 61
   61 FORMAT(25HTURN ON SW. 2 FOR TABLE 2)
      PRINT 62
   62 FORMAT(25HTURN ON SW. 3 FOR TABLE 3)
      PRINT 63
   63 FORMAT(25HTURN ON SW. 4 FOR TABLE 4)
      PRINT 64
   64 FORMAT(28HTURN ON SWS. 2,3 FOR TABLE 5)
      PRINT 65
   65 FORMAT(28HTURN ON SWS. 3,4 FOR TABLE 6)
      PRINT 66
   66 FORMAT(28HTURN ON SWS, 2,4 FOR TABLE 7)
      PRINT 67
   67 FORMAT (30HTURN ON SWS. 2,3,4 FOR TABLE 8)
      PRINT 68
   68 FORMAT(39HTO USE ONLY TABLE 1, TURN ON ONLY SW. 1)
      PRINT 69
   69 FORMAT(40HAFTER T A B L E CHOICES ARE MADE PRESS STRT)
      PAUSE
      IYRI=1849
      GO To 88
   59 IYRI"1849
      PRINT 707
  707 FORMAT(74HSW.1=T-1, SW.2=T-2, SW.3=T-3, SW.4=T-4, SW.2,3=T-5, SW.3
 7071,4=T-6, SW.2,4=T-7)
      PRINT???
  777 FORMAT(36HSW.2,3 ,4=T-8. CHOOSE AND PRESS START)
      PAUSE
   88 READ33,ISUB,IYR,XD,IU1,IU2,IPOS,IPL,IS,IR,IP
      IF((IYR-IYRI)-1)101,101,102
  102 L=IYRI+1
      LH=IYR-1
      DO103 IY=L,LH
  103 PUNCH38,ISUB,IPL,IPOS,IY
   38 FORMAT(6X,A5,6X,A5,A1,I5)
  101 CONTINUE
      IYRI=IYR
      IF(SENSE SWITCH1)21,22
   21 I=1
      IF(IU2-7000000000)4,5,5
    4 X=XD
      GO TO 17
    5 IF(IU1)8,9,8
    9 I f (IU)12,11,12
   12 K=IU2/100000000-70
      GO To 13
   11 K=0
      GO TO 1 3
    8 K=(IU1/100000000-70)*10+IU2/100000000-70
   13 K=K+1
      LU=IB(I,K)
      X=XD*XP(I,K)
      GO TO 18
   17 J=1
```

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 18 J=2
    GO TO 89
 22 J=0
    X=XD
 89 IF(SENSE SWITCH2)23,24
 23 IF(SENSE SWITCH3)25,26
 25 IF(SENSE SWITCH4)27,28
 24 IF(SENSE SWITCH3)29,40
 29 IF(SENSE SWITCH4)41,42
 26 IF(SENSE SWITCH4)43,44
 40 IF(SENSE SWITCH4)45,46
 46 IF(J-2)203,204,204
203 PUNCH39,ISUB,IPL,IPOS,IYR,XD,IU1,IU2,X,X,IU1,IU2,IS,IR,IP
    GO TO 300
204 PUNCH309,ISUB,IPL,IPOS,IYR,XD,IU1,IU2,X,X,LU,IS,IR,IP
    GO TO 300
 44 I=2
    GO TO 99
 42 I=3
    GO TO 99
 45 I=4
    GO TO 99
 28 I=5
    GO TO 99
 41 I=6
    GO TO 99
 43 I=7
    GO TO 99
 27 I=8
    GO TO 99
 99 K=IYR-1849
    XF=X/XP(I,K)
    IF(J-2)34,35,35
 34 PUNCH36,ISUB,IPL,IPOS,IYR,XD,IU1,IU2,X,XF,IU1,IU2,IB(I,K),IS,IR,IP
    GO TO 300
 35 PUNCH37,ISUB,IPL,IPOS,IYR,XD,IU1,IU2,X,XF,LU,IB(I,K),IS,IR,IP
 36 FORMAT(6X,A5,6X,A5,A1,I5,1PE11.4,A1,A1,1PE11.4,1PE11.4,A1,A1,A5,I3
361,I3,I4)
 37 FORMAT(6X,A5,6X,A5,A1,I5,1PE11.4,A1,A1,1PE11.4,1PE11.4,A2,A5,I3,I3
371,I4)
309 FORMAT(6X,A5,6X,A5,A1,I5,1PE11.4,A1,A1,1PE11.4,1PE11.4,A2,5X,I3,I3
3091,141
 39 FORMAT(6X,A5,6X,A5,A1,I5,1PE11.4,A1,A1,1PE11.4,1PE11.4,A1,A1,5X,I3
391,I3,I4)
 31 FORMAT(I3)
 32 FORMAT(6X,A5,30X,E11.4)
 33 FORMAT(A5,I5,E10.4,A1,A1,A1,A5,I3,1X,I3,1X,I4)
300 IF(IYR-1962)88,77,88
 77 PUNCH80
 80 FORMAT(80X)
    PUNCH81,ISUB
 81 FORMAT(A5)
       PUNCH82
  8 2   FORMAT(12HSUBJECT CODE,5X,5HPLACE,9X,8HRAW DATA,4X0HCONVERTED PE
821R CAPITA,7X,6HSOURCE)
    PUNCH83
  8 3   FORMAT(24X,4HYEAR,11X,2HUN,7X,4HDATA,6X,7HDATA UN,6X,9HREFERENCE )
       PUNCH84
 84 FORMAT (39X,2HIT,22X,2HIT,2X,3HPER,6X,4HPAGE)
    GO TO 59
    END
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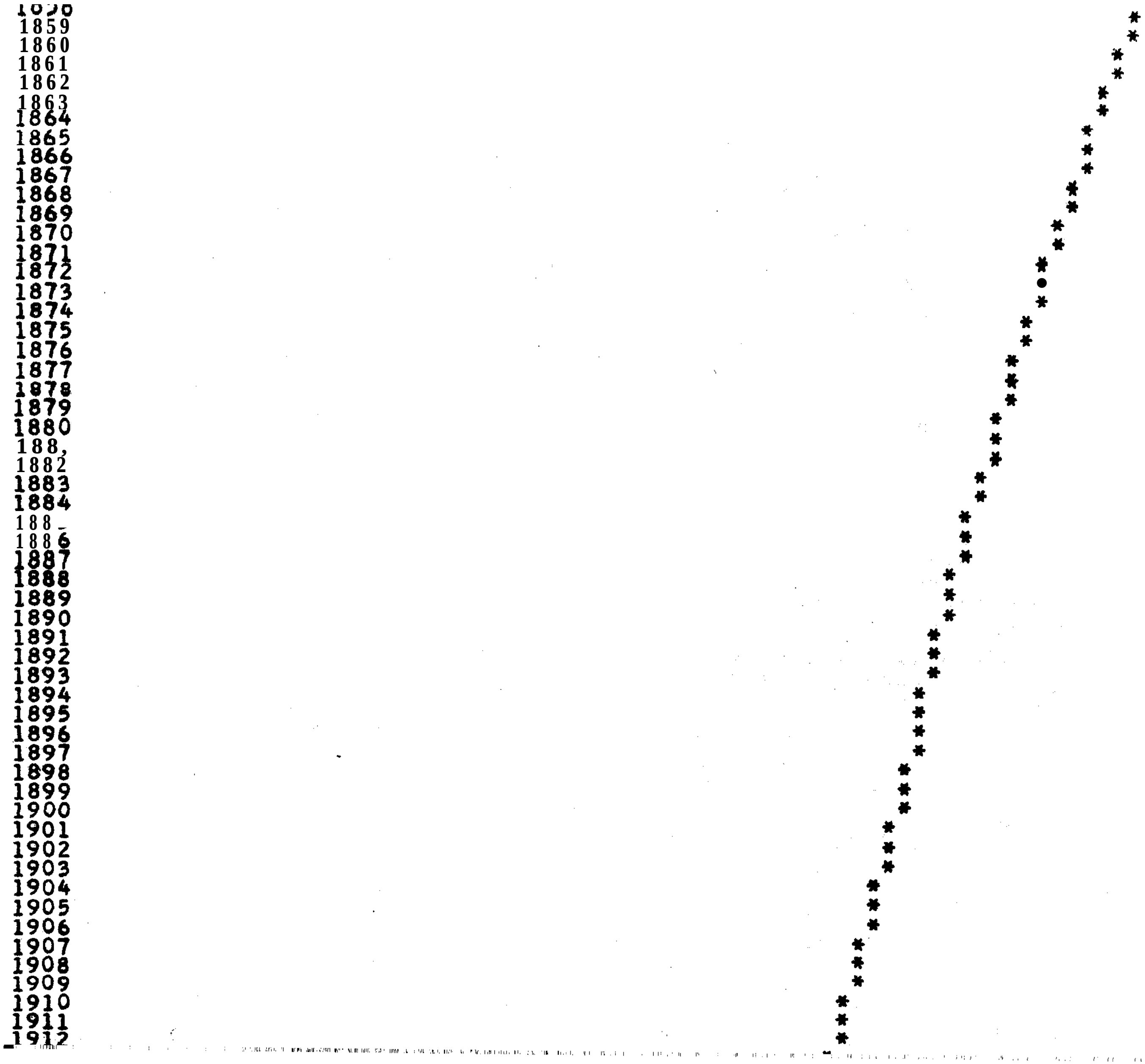
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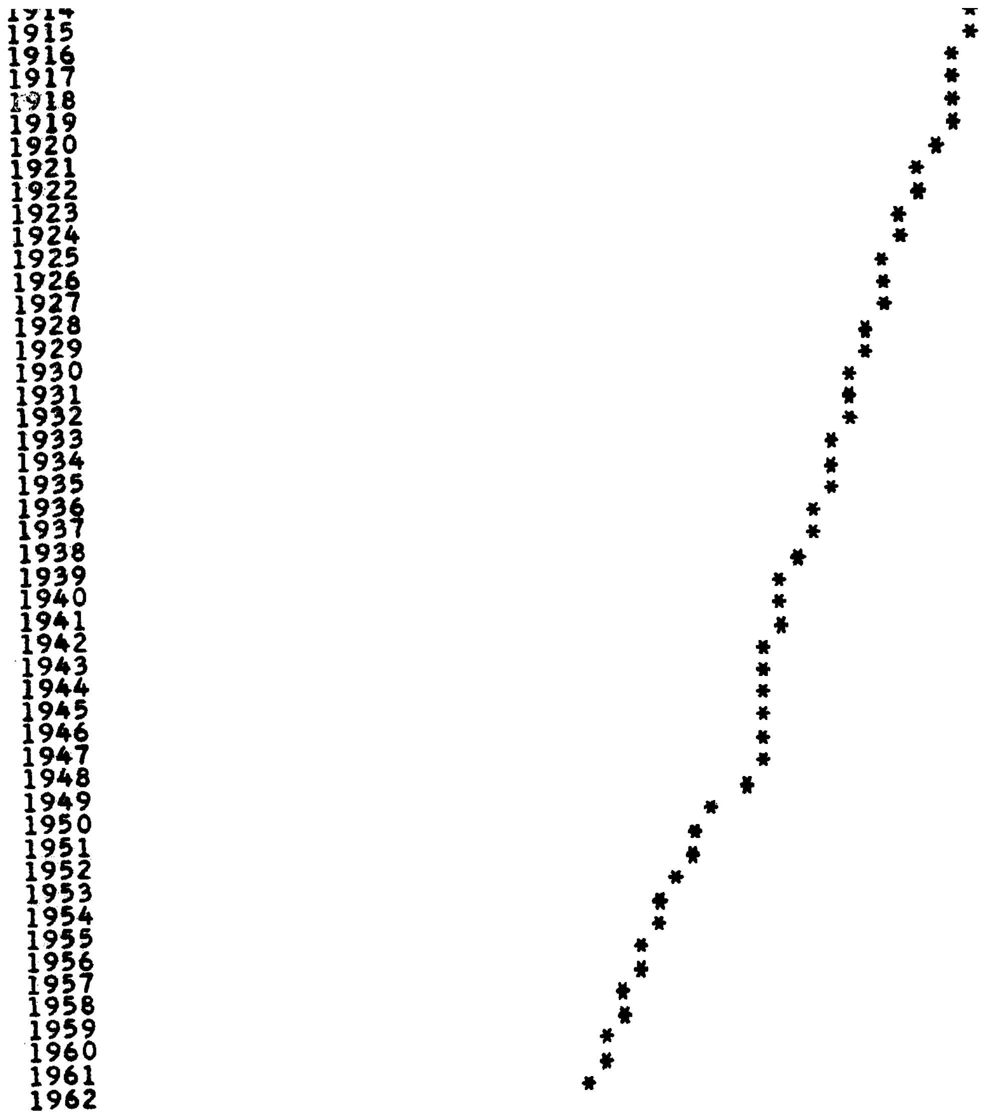
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MANUAL CONVERSION TABLE

MULTIPLY	BY	TO OBTAIN
British thermal units	778.2	Foot-pounds
Btu. per minute	1.758×10^{-2}	Kilowatts
Foot-pounds per sec.	1.818 x 10-3	Horse-power
Horse-power	42.41	Btu. per min.
Horse-power	00.7457	Kilowatts

(The following relationships were used in energy calculations)

Radio or TV set (50 lb. ave.)	1,8662 x 1O-3	Metric tons
Ton-kilometer	3.1964×10^{-4}	Metric ton eq. of coal
Passenger-kilometer*	$6,0272 \times 10^{-2}$	Ton-kilometer
1 metric ton coal (energy)	23.75	Energy slaves
Ton-miles	.6213	Ton-kilometer
1 ton coal equivalent	2.88 x 107	British thermal units
1 kilowatt-hour	.600	1 ton of coal eq.
1 sq. meter of rayon and acetate fabric	1.24×10^{-4}	Metric tons
1 sq. meter of woven wool	3.1015 x 102	Metric tons

*One passenger taken to be 150 pounds.

GLOSSARY OF TERMS

British thermal unit (Btu.): Heat energy required to raise one pound of water one degree Fahrenheit.

Calorie: Heat energy required to raise one gram of water one degree Centigrade.

Energy slave: Inanimate energy source capable of producing the same amount of work as a man; 150,000 foot-pounds per 8-hour day, 250 days per year,

Foot-pound: Work required to lift one pound one foot.

Horse-power: 33,000 foot-pounds of work per minute.

Kilogram calorie: (the great calorie) equal to one thousand calories, amount of heat energy required to raise one kilogram of water one degree Centigrade.

Kilowatt-hour: 1.34 horsepower-hours; unit of work or energy.

Metric ton of coal equivalent: Energy produced by one average metric ton of coal; equal to 28.8 million Btus.

Passenger-kilometer: Work required to move one 150 pound person one kilometer.

Ton-kilometer: Work required to move one ton one kilometer.

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