

Invitation to an Enterprise: From Physics to World History to the Study of Civilizations

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Part A.

Introduction

Landmarks, principles, evolution. The modern scientific enterprise that began with Newton about three centuries ago with his 'World View' (space, time, matter, force, and the laws of motion) and his 'System of the World' (or world machine model) has in the last century developed the capacity to treat physically complex systems. For some three decades, our interdisciplinary group has been developing a strategy or model for studying such systems. We call this model 'homeokinetics' (HK). The purpose of this paper, interdisciplinary in character and authorship but centrally physical, is to outline both a history of the natural subject study of civilizations, which are the highest form of human social organization, and to complete the introduction of such a science in time for the new millennium.

Suitable material to begin to study the enterprise is appended, starting from Randall 1940¹ and followed by a remarkable interdisciplinary conference, *Temperature, its Measurement and Control in Science and Industry* 1941², sponsored by the American Physical Society, the U.S. National Bureau of Standards, dozens of American engineering societies and companies, and the community of physiologists concerned with temperature, thermoregulation and energetic or metabolic regulation. While Percy Bridgman's book on 'dimensional analysis', mathematical scaling of complex system's processes, and his 'operational' philosophy of science was written in 1927³ (see, for example, *Encyc. Brit.* 1975⁴ on Bridgman), the basis for general scaling of issues involving systems' stability (Buckingham's pi numbers) finds its introduction in that first *Temperature* symposium.

While physiological study or the biophysics of metabolic and temperature regulation may seem to have reached the biological organism, they still have not reached the social regulating processes. That seems to have emerged in the 19th Century in the sheaf of disciplines known as sociology (Saint-Simon, Comte, Durkheim, Marx, Spencer, Ward, Weber, etc.), anthropology (Morgan, Tylor), economics (Adam Smith, Marx-Engels), history, including world history (distributed, rather than confined, from Herodotus on, reaching up to world prehistory by the 1950s and 1960s with carbon dating of fossil material and systems, e.g., see such material as G. Clark's writing on world prehistory (1969), now reaching to McNeill and his world history, the style of ecologically founded world history pursued by the Braudelians, and the work of several ISCS members, e.g., Hord, Hewes, and one of us [Wilkinson]), and politics (Aristotelian and Renaissance beginnings leading to the Enlightenment, then on to Hume, Bentham, de Toqueville, and American constitutionalism).

What is only poorly known is that the discipline, now called sociology, was at first referred to as social physics (more precisely *physique morale*) in the line of scholars from Saint-Simon and transmuted into sociology by Comte (see Chapter 6 in Iberall, Wilkinson, White 1993⁵), followed then by Spencer and Ward. Nor did the idea of a physically based social science expire in the 20th Century. In fact in 1950, J. Stewart⁶ put forth a manifesto in a physics journal, signed by many scientists, calling for such social physics study.

The processes that finally connect a social physics for humans with modern civilizations are first that the social matrix or media is an 'ocean' or collective of culture and cultures, and, second, that 'ocean' acts as a 'solvent' or carrier for the political - command-control - and economic processes for social action including the interactions or exchanges within or among cultures to permit the collective to survive.

Likely, a keynote for such disciplinary study was Karl

Polanyi's 1957 foundation for an anthropologically – based study of political economics (as value in exchange systems) in a chapter in Polanyi, Arensberg, Pearson (eds.)⁷. We have provided an HK primer for the study of civilizations (and a great deal else) in *Foundations*..⁵, a work which also contains pieces, touching on biological, social, and geophysical systems, published from 1984 to 1993.

Some source books for both our contributions of an HK nature in the literature of various other disciplines, that are also relevant to the study of civilizations, are Moore⁸ in anthropology; Yates (ed.)⁹ in interdisciplinary science for physical, biological, social, geophysical systems; Karnes (ed.)¹⁰ in international political study; Modelski (ed.)¹¹ in international relations. In the endnotes to this article, we separate out our individual pieces in the publication *CCR*, or material presented at or for ISCSC meetings or purposes 12^{12a-12l}.

Civilizations and Social Physics

Members of the ISCSC, past and present, may continue to wonder what a social physics has to do with the study of civilizations. Why in fact have we written so many such pieces in this society's publications? They may be surprised to learn that the first author of this paper walked into the organizing meeting of the ISCSC in 1971 with the idea and expectation of developing such a new science; when he recognized that a classmate from CCNY in the 1930s, the New School of Social Research Weberian, Ben Nelson, was coming on board as its first president, there soon was ample reason for undertaking such study. Thus it may be worth some note to inspect how and when our list of papers accumulated in ISCSC archives. That provides one third of the reasons for writing this paper.

A second third was expressed in a recent society letter from Matt Melko, dated July 7, 1999. He confesses now beginning to work on his last book, to try to answer questions he had raised in a book thirty years earlier on *The Nature of Civilizations*. Regarding this piece to be a proclamation, perhaps similar to Stewart's manifesto, on social physics, Melko inquires as to what

basic questions do we answer on the nature of civilizations?

The third set of reasons for this paper relates to another meeting that was held in March 1999, as the centennial meeting of the American Physical Society. The avowed purpose of that meeting, which brought more than 10,000 members of the society together, as a very considerable fraction of the total American membership, was to put forth an introduction to physics for the new – soon-to-be – millennium. Three physicists (the first three authors of this article) believed that the time had come to really introduce our subject, a social physics suitable for all human group sizes up through civilizations, to that community properly. Thus it also seems appropriate to try to offer both communities, APS and ISCSC, a commonly founded declarational keynote. As we have spelled out, it is not the first such declaration, but we believe that its time has come. As we (now including a fourth colleague, Wilkinson) will try to show, we believe that our claim has merit. So to complete this paper, we propose to do two tasks. One, we will put down in a few paragraphs, an overview of the ideas that we have presented to physicists. We believe our joint credentials assures the validity of our physics constructs. Two, we offer an interpretation of that physical description which is suitable for the ISCSC community, and in doing so answer Melko's question: How is the description that we offer for social physics to be used at all of the various space and time scales among which social processes for humans, including the civilizational process, operate to be used as governing, so-called command-control, systems? The next section can represent our argument to the physicists.

Part B.

*A General Social Physics: For Tomorrow, Next Year,
The Next Century, The Millennium*

This is a 20th Century subject whose time to emerge, as a physics subdiscipline, has come [Stewart, *Am J Phys*, May 1950⁶]. Our interdisciplinary group has been occupied with the study, as physics for complex systems, for more than two and a

half decades (<http://www.trincoll.edu/depts/psyc/homeokinetics/>).

Complexity of Humans.

People are not ping pong balls. They are physical-chemical atomistic units – persons – who engage in a very broad temporal range of intrapersonal as well as interpersonal interactions. While the range for the time scale of the former may cover a lifetime of memories, its very common operational scale is perhaps a characteristic day of action for the individual. The characteristic scale of the latter interpersonal process is a few seconds of cognition (a sensory perception or two, a spoken word or sentence, a hug). An essential element in our group's definition of complexity is the size of that time scaling ratio (intra to inter) needed to describe the behavior of a system. If that ratio is large, it makes the collective system, their social system, complex. The integrated product of energy-time measures *action*. The social collective may either be a small group who live or work together successfully, an organized polity, a civilization, or a species. That definition of complexity, at this level of unit and organization, is not measured in h units of action (h is Planck's universal constant which dominates fundamental particle interactions of 'action'; in lay talk: its activities), but as a 'factory day' of action H_0 for people. H_0 is about 2,000 kcal per Earth factory day. For other mammalian species, our biophysics has scaled H with the $4/5$ ths power of unit adult body mass. Thus, human factory action scaling, its metabolic energy, is 2,000 kcal-days per Earth factory days. These are the physical definitions.

The Fluxes, the Equations of State and of Change

The processes whose persistence defines and maintains the system, are five in number of types, X_1 to X_5 . X_1 is the energy, which at the organism level is the nominal metabolic flux of 2000 kcal per day per person, and at the social level includes all other energy requirements. X_2 is the individual flows of molecular matter – e.g., carbohydrates, fats, proteins, and all other required

materials. X_3 is the performance of characteristic actions – e.g., rest, work, procreation, recreation. X_4 is the demographic process involving maintenance (and growth) of the population number. X_5 – for modern human societies – refers to the economic processes and variables, and is given, by us, the short-hand description of a “value-in-exchange” measure (To grasp our group’s usage of the economic variable, invented by humans out of mind, the reader is again referred to the anthropological economics of K. Polanyi⁷, rather than the mathematical economics of K. Arrow; see S. Hook, *Human Values and Economic Policy*).

If these systems are hierarchically complex, e.g., are both consumer as well as producer societies with complex command-control governing processes, the balance extends to those levels also. The variables, X_1 to X_5 , will be found to be bound in common by relations called the ‘Equations of State’ that describe their codependence. In addition to the Equations of State, there will be found ‘Equations of Change’ which give the rates of change of the variables in terms of the internal and external ‘forces’ or ‘potentials’ that govern and drive the system.

Driving potentials

Human collective systems (including civilizations) are embedded in an Earth’s environment that affords the following sheaf of driving potentials: a) Solar flux; b) Earth’s atmospheric temperature potential (more properly, the specific energy per degree of freedom); c) Physical-chemical resources of support platform Earth; d) On-board chemical genetic potential; e) Technological rate potential emergent from physical-chemical brain that suggests tool changes that augment and increase the action flow streams (beginning among hominids 2-3 Mya); and f) A value system which – while foundationally physical-chemical – currently has to be identified by behavioral categories – world images of self, interpersonal relationships, of nature, of society, of ritual and institution, of other living organisms, of technology and culture, of spiritual causality (fathers, leaders, gods), of art forms (abstract attention attraction in sensory modes), in a weak sense of capability for abstract rational thought.

[PNAS-USA, Sept. 1985¹³; *Foundations for Social and Biological Evolution*, 1993¹⁴; *Phys. Today*, Letters, Feb. 1994¹⁴; *Science*, Aug. 18, 1978¹⁵; *Perspectives in Biomechanics*, Vol. 1, Part A, 1980¹⁶.]

Part C.

Interpretation

Social physics depends on and involves five flow variables. That physics is essentially obligatory. There is a flow of *energy*, 2,000 kcal/day per adult in the region. How do you know that? It is written on effectively every article of food in America. Expressed on the left hand side of the equation, the right hand identifies all the moderate sources or causes that change that amount of daily energy. For example, you may work harder, you may absolutely loaf, socially you may be prevented from acquiring that energy, there may be other stresses put on your body organism, or in a collective group you may find other ways to change that daily expenditure (e.g., you may steal or plunder it also). To study a civilization under the guidance of social physics, one must map and scale its energy flows.

Second, there is a flow of *materials*. You know that. It is drummed into your head. You eat carbohydrates, proteins, fats or oils, drink water, ingest some vitamins and minerals. There are compendia of other RDA's (required daily allowances) spelled out for you in many sources, including a number of government agencies, societal groups, and the news media (e.g., calcium, iron, and the like, by medical and consumer groups). Of course, you may have cultural ideas on how your components are supplied, but regardless of the form - filet mignon, horse meat, fish, chicken, beef, vegetables, fruits, etc., rich or poor foods, - they all serve. You and your leaders have to juggle the right side of the equation to determine, once again, how the supply is arrived at or changed. To study a civilization according to the program of HK social physics, one must map and scale its material flows.

If you were involved as or with a simple flow field, your third flow variable would be the momentum flow, described by Newton's law of motion, in the form that the rate of change of

momentum is given by the net force. (The usual text form of the law, involving force, mass and acceleration, is $F = ma$.) But in a complex system, we have argued that the bits of changing momentum are integrated into the daily modes of *action*, or activity; in lay terms, the things that the complex organismic system does. In technical physical language, an important measure of an action mode is, as previously alluded to, the product of the energy and time scale of the action. In total, the action is 2,000 kcal-days per Earth factory day for an adult human. That is the idea which is buried in what is called the circadian rhythm.

But what constitutes or uses up that energy are, first, the maintenance or survival modes. Of the 2,000 kcal, about 1300 of them are used up in maintenance. How do we know that? Experiments done on prisoners, with "informed" consent, show that humans become moribund at about 1700 kcal (per factory day). The vicious Nazi experiments tested levels of near starvation down to 500 kcal and also absolute use-up starvation. The latter demonstrates how many total kcal are stored in the body. Less vicious experiments or accidental starvations show the level to be perhaps 30 days or so in time. Thus 30 days x 1300 kcal (per factory day) represents about 40,000-50,000 kcal as the approximate storage capability of the total body. Another way to test those numbers is by the rule that carbohydrate and protein supply about 5 kcal per gr. of 'food' while fat supplies about 9 kcal per gr. Skipping water content and bone, one can imagine perhaps 25 pounds to be cannibalizeable (by 'us' them, or them us) from a 150 pound human being. This amounts to about 500 gr./pound x 25 pounds or 12,000 grams total food, at about 6 kcal per gr., or about 70,000 kcal. These two numbers, 50,000 to 70,000 kcal, check out as similar magnitudes of what your organism carries. To study a civilization sociophysically, one must map and scale its action modes

Can a collective live with those three flow variables? Yes, but it cannot persist. Provision must be made for *population* reproduction from its ancestors through its successors. So the fourth requirement is the reproduction rate. At steady state, the number

of people born who live an expected life length (e.g., 40 to 90 years, but more than 20-30 years) has to equal the number dying per year (why not the factory day of an Earth day? Because reproduction takes 9 months human gestation, and related times for human sized animals, so that a year is a more suitable 'factory day' for primate or other large mammal reproduction, which basically is a rare action, not done every day).

We do not operate at steady state. Nor are we permitted to operate far above steady state for any great length of time. The Earth or other available environment would run out of stores. And we cannot operate too far below steady state. The local group or species would get lost. Thus we have had to show, per data and theory, that the birth and death rates cycle around each other to be near a zero equilibrium. The need for a margin of safety against extinction in the chemical genetic competition with other species demands an average small positive net rate of increase (Demetrius 1984¹⁷). Humans for the past 120,000-40,000 years have performed in that fashion. A small sample of national and regional population growth and the slowness of its rate can be inspected for the past 2,000 years, with connections to perhaps 10,000 ya, in McEvedy and Jones, 1978¹⁸. The subject is also reviewed in a simple fashion in *Foundations*..⁵ in Chapters 1 and 2. To study a civilization homeokinetically, one must map and scale its demographic flows. If you manage a zoo or a farm or a jail or a family, or a tribe, these are the four variables that you have to take care of within the genetic and Earth potentials. Now for the difficult fifth flow variable in more modern human societies.

Value-in exchange; the Modern Economic Variable

According to our HK interpretation of human history, a "phase" transition from hunter-gatherer life to settlements occurred when the viable land areas of the Earth were about to be fully occupied by hunter-gatherer groups. The need for a higher density social organization led to the invention-adoption of the technologies of farming, herding, mining. These, in turn, led to

the storage and accounting of goods, and to trade (and war), thus giving rise to the new flow variable, the economic variable of value-in-exchange. (Note that very much earlier in evolutionary history, similar "inventions" arose, as in gene transfer and various forms of symbiosis.) This new value is formed out of a complex integration process involving all the other values, and in turn influences those other values. In particular, we note that the economic variable influences technology, and technology influences economics.

Consider the problem as it exists today and also 10,000-15,000 ya (e.g., from the earliest Mesolithic, precivilizational startup of the Kebaran; see data abstracted from Mellaart in de Laet, et al UNESCO and reviewed in note 121, and also *Foundations*..⁵, Chapter 5). In a modern large polity, e.g., USA, EU, there are perhaps 50-100 M households. They range, politically and economically (as a *political-economic* variable) from the potential support level, measured not in current or disinflated indexed year dollars, francs, marks, rubles, but in poverty 'living-level' units (costs for poverty level living for households (HH's) as food, clothing, shelter, and other essential services required for life support and population maintenance). This is our form of acceptance of the Polanyi anthropological exchange value system notion into social physics. At one end of the social spectrum are those HH's that live at a considerable fraction of a poverty level unit (PLU) such as 0.7. In the middle are those who live at the 2-5 PLU level, and at the extreme are a few hundreds of the 'elite'; C. Wright Mills among others is known for having popularized that group and its power. Or, scaled currently, *Forbes* lists yearly the top 'billionaires' (perhaps soon to reach the 'trillionaire' level, since they already exist at the one tenth trillionaire level), who operate their HH's with 100,000-10,000,000 PLU's (at some point representative of conspicuous consumption?).

Although its validity has not been adequately tested (both experimentally and theoretically), we expect, in consequence of our fundamental theoretic, that there will be shown to exist a scaling relation between the population of the larger political

entities, including civilizations, and the annual compensation – their ‘take’ in PLU’s – for the elite at the elite margin or the starting level of that group (e.g., as what we have been able to identify as the topmost group of about ‘500’ HH’s). That scaling theory is a dynamical theory of the growth, development, and evolution of the species in the world with time. For humans that growth coupling has existed for the past 11,000 years (see *Foundations*..⁵) of urban civilizations. The connected scaling takes place by the combination of agriculture and other supply potentials producing surplus, and technology being able to increasingly exploit the surplus.

Beyond individual polities, consider the ‘world’ picture, the UN’s 180 odd polities, with perhaps one or two billion HH’s (congratulations are in order to fellow humans; we have just reached a population of 6 billion persons) who also require their supra – total management. The challenge is to accomplish that task in a fashion amicable to all concerned.

Among organizations who have tried to study such problems, one can note currently that the MacArthur Foundation has a competition for the following stated purposes: “To support innovation and excellence in the analysis of the causes, nature, and consequences of international conflict and cooperation and in the development of improved understandings of social security and sustainable development.

“It seeks to support research ...projects that promise to illuminate the dynamics of international security, sustainability, and cooperation....” Apparently, a second such competition is also forthcoming.

We believe that our social physics can illuminate the dynamics of international relations. At least the technical organization in the community of International Relations, the International Studies Association, stated in 1986 that our program offers one of the first significant theoretically founded programs in their field¹⁰. Perhaps we may in time find interested supporters who may take the authority of our assertion more seriously than merely an academic exercise.

Our colleague, co-author, Dave Wilkinson, has put forth the claim of one central civilization in the ISCSC community. We, now four authors, do accept that the social physics of humanity has been involved loosely or intermittently in one such central 'civilization' problem of organization for nearly the past 15,000 years, and we point out how difficult and intractable the problem is -- given the 500 year near periodic epoch for individual cinematic (and kinematic) episodes that have already occurred -- to outline that epic drama. It is truly a serial *Perils of Pauline* movie for human children to write, direct, and act in. At least with a social physics background for the next millennium, one can minimally bite off pieces to chew on; with world histories like those of Barraclough, or McNeill, or the Braudelians, or two noble efforts by UNESCO, as well as *Foundations* .. here to help you, and there are some rudiments of a script. In recapitulation, here are the driving potentials which are needed to drive the five human flow variables.

1. You have to manage your piece of the problem of the record of flow variables and driving potentials for your own organism (for 70-90 years?), for your family's HH (even as their constitution changes in a variety of abodes and phases of your life) regardless of how many PLU's you operate with.

2. Beyond that, you also have to control the larger problem: management of the highly organized congeries of producing, distributing, and maintaining units. These are built on the existing technological potentials and their changing rates, the so-called economic productivity, as people are told to view the technological scene. We refer to this in HK as the technological rate potential, wherein we use 'tools' to augment the capability of our organism-driven actions. In order to permit that growing structure-function of population to persist in increasing in the civilizations' phase of humanity, it is essential and fundamental to understand that the drive of technology and its change is the major process that makes such growth possible.

Acting on the Homo sapiens form of our hominid kind, we expanded out over the Earth. By about 11,000 ya, growth into a

local dense form of urban settlements began to be supported by technology producing agricultural surplus. Our human bodies can directly manage perhaps 500 kcal of volitional action during each factory day, applying direct driving stresses up to the level of our bone structures. That got us our Homo ancestors' hunter-scavenger-gatherer life style. However, with suitably augmenting tools – technology - and including language and cooperation, we now manage to augment that fraction of one horsepower each up to perhaps an average nearer to 100 horsepower (literally, until it begins to seriously compromise the total availability of power storable in our Earth's total environment).

3. Beyond that is the management of the political scale, perhaps 2-6 years within the local polities. Then there is the bio-physical – biochemical – scale of the generation: reproduction, nurture, education, absorption into the productive succession of generations, i.e., the nominal centennial problem, and beyond that the nominal millennium problem. We now finally learn to appreciate the role for a *value* system – which relates to how and what command-control is exercised for, and that it has to be shared by elite, pauper, and political-economic governor near-elites alike.

We repeat the value system – for humans - as a set of nine world images and a tenth compartment relating to rationality to be described below. Even though the values all deal with real internal chemical potentials, we humans do not treat them as such. Neither do most other living organisms. Rather, we humans operate them as human managers of their enormous chemical factory-laden companies whether they are our community, our city, our nation, our beehive, our forest, or our particular species. They are like some complex form of a Dupont, Monsanto, Union Carbide, Imperial Chemical, General Electric, etc., each of whom has dozens of plants strewn all throughout the Earth's environment. In that complex of operations, we see how the production, the distribution, and the long term maintenance emerges.

We may suppose that the metaphor which describes what we are talking about is contained in the statement that to run one of

those complex company systems, you do not have to be an expert chemist or scientist. Rather you have to be a competent chemical engineer who understands unit engineering processes and is willing to take guidance from a more expert chemist on the reaction details he or she wishes to entrain, or is willing by experimental trials to develop a chemical chain that provides sufficient yield. That really expresses the difference between the engineering guidance of a system and scientific guidance (the science and engineering that make up our technology). Or, as another targeting remark indicates, you do not have to know how to design a car, only to drive it and provide suitable maintenance programs.

4. We return one final time to the value system as a driving potential. The value system for humans consists of ten compartments or components. Nine are images:

a. Of self and outer world (for Dupont, it is a specific production plant, and the location and conditions whereby that particular plant is managed, etc.)

b. Of interpersonal relationships (as one last illustration, for Dupont it is the collection of unit processes that make up in the plant, not the 'organs' of the plant but the organisms, so that the plant can be used as a general purpose manufacturing unit, not only one product alone. Plant designers of such turnkey operations really do understand how to provide such working design, and they have had such changing and growing skills for millennia of experiences. You can see this in the early learning experience of various architects as they developed the art of building the pyramids that early pharaohs of 4-5 millennia ago began to desire, and they to design.)

c. Of nature (you do have to understand your environment)

d. Of society

e. Of ritual and institution

f. Of other living organisms

g. Of technology, more broadly of culture

h. Of spiritual causality (fathers, leaders, gods)

i. Of art forms (abstract representations designed to attract attention within sensory modes)

j. In a weak sense, the capability of forming abstract rational logical thought

We assume the reader understands that the number and organizational level that this litany carries depends on the species. "Lower" species do not have these full ten compartments. They may only have a few of the bottom ones. Yet currently, mid 1999, experimental data is accruing that higher human planning processes are apparently to be found at considerably lower primate organizational structure, i.e., in rhesus monkeys¹⁹ – learned decision making by assessing the value of each possible response (see Platt, Glimcher, *Nature*, July 15) operating out of such decision competence at the neural level within the parietal cortex (The article's authors state that "in [the free-choice they have presented their test bed and animals], both monkeys and posterior parietal neurons behaved as if they had knowledge of the gains associated with different actions. These findings support the hypothesis that the variables that have been identified by economists, psychologists and ecologists as important in decision-making are represented in the nervous system.").

We have to view this as strong support for our HK modeling, even if we do not subscribe to the thesis that the decision-making choices made are to be represented by the economists' rank ordering utility function assessment. Just as we realize that our human so-called rationality is not quite up to an ability to run and design an 'automatic factory'. Just as we do not yet know how to design a controller that can handle all aspects of the management of a flying system. We are not yet ready to trust even an automatic pilot to manage all components of a continental flight. It can take care of a segment of smooth straight flight, but not take-off and landing and weather conditions changing suddenly. (Even a model airplane system is too costly to be trusted by its owner to manage its own flight. He or she manages it from controls on the ground. Else, one soon has a smashed model).

There are other things that we can do and still not do. Some of us have been married for nearly 60 years. It still remains a dif-

ficult learning experience.

The major lesson we believe we have to offer for modern human life is that in order to maintain the continued growth in population, we have had to learn a new form of symbiotic attachment to animals and plants, and even minerals as managers and lords of the land. Thus arises the stability transition from human valued individual and group life to value-in-exchange and wealth (when *E.coli* took up residence in human guts, it may have shortened the species life, but it certainly made their living so much easier). In this brief paper, we cannot develop our themes completely, only suggestively, so we move on.

Species management still remains a difficult learning experience. As a minor note very few of us are Mozart's, Beethoven's or Brecht's in our art competence, e.g., of music.

Upon those two notes, we close.

Welcome to the enterprise!

- A. Iberall retired scholar, UCLA
- F. Hassler systems and R&D policy, US Dept. Transport.
- H. Soodak Physics dept., CCNY
- D. Wilkinson Political Science dept., UCLA

NOTES

1. John Randall, *The Making of the Modern Mind* (Houghton, Mifflin, Boston, 1940).
2. *Temperature: Its Measurement and Control in Science and Industry* (National Bureau of Standards, D.C., 1941).
3. Percy Bridgman, *The Logic of Modern Physics* (Harvard Press, Cambridge, 1927).
4. *Encyc. Brit.*, Bridgman, Percy (1975).
5. Arthur Iberall, David Wilkinson and Doug White, *Foundations for Social and Biological Evolution* (Cri-de-Coeur, Laguna Woods, CA., 1993).
6. John Stewart, "The Development of Social Physics," *Amer. J. of Physics*, 18 (1950), pp.239-253.
7. Karl Polanyi in *Trade and Market in the Early Empires: Economics in History and Theory*, eds. Karl Polanyi, Conrad Arensberg and Harry Pearson (Free Press, Glencoe, IL., 1957).
8. Alexander Moore *Cultural Anthropology: The Field Study of Human Beings* (Collegiate Press, San Diego, 1992).
9. F. Eugene Yates (ed.) *Self-Organizing systems: The Emergence of Order* (Plenum

Press, NY 1987).

10. David Wilkinson and Arthur Iberall "From Systems Physics to World Politics: Invitation to an Enterprise," in *Persistent Patterns and Emergent Structures in a Waning Century*, ed., M. Karnes (Praeger, NY 1986). Examine the prefatory material and the first two chapters. The second chapter is by DW and AI.

11. Arthur Iberall and David Wilkinson "Dynamic Foundations for Complex Systems" in *Exploring Long Cycles*, ed., George Modelski (Lynn Rienner Publ., Boulder, Colorado 1987).

12. Material specifically based in ISCSC archival sources, e.g., *CCR* or invited presentations.

a. Arthur Iberall "On the Thermodynamic Theory of History," *General Systems Yearbook*, 19 (1974) p. 201. Presented at the initial meeting of the society, devoted to honoring Toynbee; it was left out of the periodical *Mainsprings*. Instead, it was finally published in *General Systems* after review by the physicist Henry Margenau

b. Arthur Iberall "Physical Principles for Organizing Civilizations." Invited ISCSC post-banquet speaker's lecture, Bloomington, Indiana (May 30, 1981).

c. Commentator Session ISCSC. A seminar on "Iberall's physical modeling of civilizations" (May 28, 1982).

d. Arthur Iberall and David Wilkinson "A Physical Tutorial on Hord's Review of Iberall-Wilkinson in Modelski's *Exploring Long Cycles*" *CCR*, 24 (Spring 1991) pp.84-96.

e. Arthur Iberall and David Wilkinson "On Defining Civilization" *CCR*, (Spring 1993).

f. (Three more papers come to mind but do not easily spring into hand. One, Iberall prepared an invited paper for the 1980 Annual ISCSC conference for sessions on the economic origins of civilization (and as a result was invited to present a paper at the organizing conference of the Eastern Economics Association), and - further - preparation for one on the death of civilizations. Second, Iberall joined Wilkinson in an attempt to model the initial human ur-language, or at least a model for a few handfuls of basic words. Another third paper and talk was prepared as the 'loyal opposition' to Kuhn's presentation on an appropriate anniversary of a second edition of his paradigm thesis. Melko, if recalled correctly, was the thrust behind getting Kuhn to our meeting - upstate NY, recollection says. That critiquing talk is engraved as Chapter 1 in a small book published in our Gen.Tech.Serv. Inc. company, on *Nature, Life, Mind and Society*, Iberall (1976). Early in 1999, the Physics Nobelists Steven Weinberg reviews his attacking critique on Kuhn's paradigm notions from some considerable familiarity with Kuhn during common school days in the pages of the *NY Review*. Because of the coincidence of our dual writing a generation apart, Iberall did correspond briefly with Weinberg. Somehow physicists take a different view of the theme than do others).

g. Arthur Iberall and Doug White "On a Characteristic 500 year Process Time in Culture-civilizations" *CCR*, 32(Spring 1995) pp.146-162. This paper was initially prepared and presented to ISCSC at its 17th annual meeting at Hampton University in May 1988. White and Iberall, with some added work got it published in 1988 in the European geography journal, *GeoJournal*; for added exposure, with the magazine editor's approval, we published it in our book *Foundations...* in 1993. That book was supposed to be reviewed at our Dublin meeting, but time did not permit an adequate period for discussion. Holton, on the ISCSC's board, thought that the 500 year piece was so illuminating that he offered to see that it got published in *CCR*. Thus the final Spring 1995 version presented it in or under the ambiguous title of a forum.

h. Robert Holton "A Response to Iberall" *CCR*, 32 (Spring 1995) p.163. Holton did us the great honor and courtesy of a brief review of our 500-year model piece in that same *CCR* journal issue. The stunning point he made to us, in critiquing our physics, was that we did not seem to pay any attention within that limitless physics to the communications aspects in the social system. We responded with delight. First we appended a list of our contributions to communications science which, among other sources, we had been led by Warren McCulloch and our Army research. Then we pointed out that we had been asked to prepare a talk on language, but it had inadvertently been swept off the program a year earlier. So we reworked that paper and it appears next, with a brief introduction to the scene.

i. Arthur Iberall "A Friendly Countercomment to Holton" *CCR*, 35 (Winter 1997) pp.63-66. That scene is set by listing some of the HK bibliography in language and communication, as part of a physics of complex systems.

j. Arthur Iberall and David Wilkinson "On Understanding Language" *CCR*, 35 (Winter 1997) pp.67-86. In this piece what had been promised for preparation a year earlier now appeared [As a small buried footnote, since the question had been asked obliquely at one time by Melko, how come this bibliography is not more extensively festooned with the writings of Wilkinson in and for ISCSC? The answer is simple. Wilkinson's writings, with a few other people, have basically dominated ISCSC analytic discussions. It would be foolish and brash to claim it all for ISCSC. Thus we in HK cut him his more modest share. In a similar vein, the authors Iberall, as well as Hassler and Soodak, do not display their other scientific-technical writings. Since Iberall does claim, particularly, interdisciplinary contribution, if he selected from his CV other pertinent writing but not confined immediately to ISCSC archives, he would add another hundred or so additional references. That is completely unseemly.]

k. Arthur Iberall - Book Review "Carroll Quigley on the Matrix of Civilizations: A Dialectic" *CCR*, 39 (Spring 1998) pp.106-134. Why a or this "review"? Because, regarding Quigley as one of the most important contributors to civilizational theory, Melko wanted to have a broad spectrum of reviewers of Quigley's main book contribution. Iberall was a suitable counterpoint. Thus he was invited. The job had to be done responsibly and responsively, and regardless of how the reader judges the review it was done with considerable care. A second reason, connected with the first, was that Iberall had reviewed an important book, Cavalli-Sforza, for the June ISCSC meeting at Pomona. The total subject that Cavalli-Sforza treats with his colleagues was *The History and Geography of Human Genes*. It was a case that Iberall's interdisciplinary background including physiology and biophysics was thought to be useful in reviewing the book. This may have also influenced the next flurry of reviews.

l. Arthur Iberall. Three book reviews in *CCR*, 40 (Spring 1999) pp.90-105. Read as a connected string, they tell a most complete and powerful story about a theory and unfolding a theory for civilizations. What this author learns from his own review writings is that he started as a complete novice in the 1960s when he happened by accident to buy a copy of Mellaart's *Earliest Civilizations of the New East*, while on vacation, in a small but gorgeous book store in Bermuda which carried Hudson and Thames books. And, 30 odd years later, he notes that having joined ISCSC, found anthropologists and other social scientists to befriend, e.g., Wilkinson, and spent a great deal of US Army research money, he comes out with an outlook and perhaps comparable knowledge to Mellaart's also 30 years later. That is what these reviews of Spring 1999 tell this author. And so now this piece. Join us, we say once again in our enterprise.

13. Arthur Iberall "Outlining Social Physics for Modern Societies: Locating

Cultures, Economics and Politics: The Enlightenment Reconsidered," *PNAS-USA*, 82 (1985) pp.5582-5584.

14. Letter and Response. Arthur Iberall; P.W.Anderson. *Physics Today* Feb. 1994.

15. Harry Soodak and Arthur Iberall "Homeokinetics: A Physical Science for Complex Systems," *Science*, 201 (1978) pp.579-582.

16. Arthur Iberall, Harry Soodak, and Conrad Arensberg "Homeokinetic Physics of Societies - A New Discipline: Autonomous Groups, Cultures, Politics," in *Perspectives in Biomechanics*, Vol.1, Part A, eds., H. Ruel et al (Harwood Academic, NY 1980).

17. L.Demetrius "Self-organization of Macromolecular Systems: The Notion of Adaptive Value" *PNAS-USA*, 81 (1984) pp.6068-6072.

18. C. McEvedy and R. Jones, *Atlas of World Population History* (Penguin Books, NY, 1978).

19. M. Platt and P. Glimcher "Neural Correlates of Decision Variables in Parietal Cortex," *Nature*, 400 (1999) pp.233-238.