Primer on Homeokinetics: A Physical Foundation for Complex Systems

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Introduction

On the occasion of Arthur Iberall's 80 birthday, his friends and colleagues of 60 years and beyond come together as a rich sample of clans - tied intellectually, by blood, by vocational interests, or, by emotional empathy with the honoree or his themes. The two authors are tied by strong bonds, effectively to almost all who will be present, and many more whose corporeal presence could not be evoked, except in their exchange spirit. It simply is not necessary to dwell on the fact that such bonding is truly a physical process measured by the energy invested in the long run in such bonds.

Historical Perspective

Omitting the 12th-19th Centuries of earlier history, the 20th Century provides perhaps four prior examples of manifestos calling for similar scientific study. One is Henry Adams' "A letter to American teachers of history", 1911, calling for them to work with physicists on the basis of a thermodynamics of historical processes. A second is a three day symposium proceedings, 1939, *Temperature, its Measurement and Control in Science and Industry*, sponsored by the Am. Inst. of Physics, with major cooperation from National Bureau of Standards (NBS), National Research Council, 12 engineering societies, other agencies and companies. Iberall started work at the NBS the following year, and most of his technical mentors were contributors to that meeting. Its manifestos still ring in his memory banks. The third overt manifesto is found in J. Stewart, The development of social physics, *Am. J. of Physics*, May 1950. A fourth is one by one of our mentors, E. U. Condon, who made two issues of *Rev. Mod. Physics* available, in 1952, to introduce biophysics seriously to the physics community.

The relevant physical and engineering physics background that could and did lead to homeokinetics was epitomized by the following starting conditions and studies. First, with Federal Government rating as physicist-instrumentation, later physicist-general, starting within the junior professional line and advancing with time, one of us was concerned with atmospheric and compressed gases, involving measurement, kinetic theory, instrumentation and development covering the major variables of pressure, temperature, density, and flow, both steady state and dynamically changing. These variables often had to relate to atmospheric pressure-altitude up to perhaps 60 miles. The aircraft industry depended on these products; also meteorology for weather prediction, and the military for high speed and altitude performance. These applied problems led to high speed so-called speed-of-sound rates of flow, to more that one phase flow (e.g., gases and liquids), two or more stream flow theory, metastability, solid state metals research both for steady state loads and dynamic - changing - states. This irrevocably led to the problem of turbulence as distinguished from laminar flow. That also led to the full Navier-Stokes equation set, a nonlinear high ordered mathematical physical construct that still leaves much to be desired in solution. What is important and basic, from a homeokinetic perspective, is that these Navier-Stokes equations connect the lower level atomistic-like components with the upper level collective processes in the material-energetic substance. In fact, in 1956, Iberall was involved in the running of a very famous

boundary layer symposium sponsored by IUPAP (Int. Union of Pure and Applied Physics - such sponsorship lends considerable credence to the homeokinetics claim of a need for both 'pure' and engineering physics for complex problems) in Freiburg, where the entire hydrodynamic clan, including the first USSR contingent after Stalin's death, gathered to try to unravel some core of the Navier-Stokes problem after its first 100 years struggle. Homeokinetics, not yet quite born, also had to struggle with the shadow of the safe human operation in space. Iberall, occupied all through WW II with the problem of 'Man' at high altitude and in Space for Navy, Air Force, by 1947 suggested to the Navy that it was time to begin the development of space suits. People representing both the Navy and Iberall's NBS crew from 50 years ago are present at this 1998 Homeokinetics Conference to lend witness to the difficulty of that human-machine linkage problem. It was such connections, referred to as both up-down or in-out connections (as nested hierarchy) and side-side or 'flatland' physics among atomistic-like components (heterarchy - McCulloch's coinage) that became the hallmark of homeokinetic problems.

Operational Definition of Homeokinetics

1. The central task that is undertaken is the intellectual basis of explanation for essentially all the systems out there and inside ourselves.

2. In the mid-1960s, the term homeokinetics was coined de novo, to represent complex systems of atomistic-like entities - "atomisms" - in which the time delay of action (the energy-time product of function) would represent a limiting long time scale, as a fundamental process, or a periodic reciprocal as a very low functional frequency, compared to the collisional exchange of action between or among neighboring atomisms. That is the operational definition of homeokinetic complex systems. Its depiction is not a simple task.

3. The companion piece to that operational definition for homeokinetic systems is an essential logical-philosophic characterization for causality, particularly as complex systems are affected. We have offered the following outlook in the early 1970s: The operational chains of causality in a system are derived from a closed loop, e.g., a circular array of functional processes (achieved from the fumbling exploration of all available directions - this is exhibited both by persons and Nature). See Iberall (1974), a first paper inspired by Toynbee, Margenau, and the organizing meeting of the ISCSC. This homeokinetic principle - it is conceived - provides the foundation for a physical thermodynamics or a thermodynamics of engine processes. There is a path that connects A to B, in one or more steps, and B to A, but not in the same 'direction' (time frames). That is, thermodynamics represents a connection of two or more linked space-time processes (or a sequence in a higher ordered n-dimensional string of processes) which are both symmetrical in the time dimension, yet represent a pair that exhibits both symmetry and symmetry breaking (Why? Because the energy goes off in different directions and is lost to the particular system of isolated concern). The nonlinear coupling between the pendular motion and the escapement motion (its continuing search for escape from its detent) in a clock is a very simple illustration of that closed loop or circular chain of causality. The homeokinetics incorporated in this point may seem more cumbersome than the physical process it attempts to deal with, but physical causality is not a simple notion to explain and understand particularly in complex systems, and it is key - in the end - for all processes. It is associated and arises - not only from the laws of symmetry in physics, but from the law

of inhomogeneity in the universe of processes and how form-function emerge through dynamic change in the total universe of being.

Methodology to begin thinking in homeokinetics terms

4. Jump the hurdles from history before to history after, if that history were changed by your effort. How does homeokinetics operate to identify form and function, system and process, in classic Greek terms, the being now from the becoming before and after.

5. Choose your field and scale of observation. By definition, it puts you the observer into the picture, at your observation scale - of space-time, at a near negligible energy or action of interactions (key word). Recognize this as a problem within the Bridgman view of instrumentalism (*Encyc. Brit.*). Thus instrument augmentation will be expected to follow. The status of evolutionary technology will be significant in and to the measurement.

6. Learn all the possible directions you are 'free' to explore, the inhomogeneity of levels and columnar chains that seem to interact to produce form and function (key words) as in a system (key word).

7. For the use of a language suited to homeokinetics, use the common language as found in a good dictionary. This follows the great mathematician, Kleene's, advice who observes in his text on metamathematics, that the logic he takes recourse to, for a start, is the common logic. He notes that if the student or scholar who wishes to pursue Kleene's subject is not willing to accept that starting point, then they should take up bee-keeping.

8. As you go up and down in a nested form, you will gradually learn about and appreciate that there is a 'vertical' hierarchy of interacting players. The hierarchy consists of a diversity of players who influence each other. That vertical array of influences carry the few - small number - of physical forces that create the beings, their states, and their becomings, their rates of motion and change (key notions).

9. Aristotle literally, if not perfectly, philosophically enunciated the concept of forces as causal for motion and change. However, physicists prefer to attribute its 'hard-nosed' start to Newton and his time, e.g., 1690. [We will give the sense of one word apparently being used metaphorically, as a sample of words which are not meant to be metaphoric. Press your hand hard against your nose until the process becomes limiting. That is our meaning of hard-nosed].

10. As known today, there are not more than four forces which have been integrated into three, and may yet - in physicist's expectations - be reduced to two, and even one. Their litany is the list of gravitational, electromagnetic, strong nuclear, and weak nuclear forces.

11. Operationally, the observer may think through all four to grasp what governs form and function. Most commonly the electromagnetic and gravitation will be involved.

12. In Newton's time, force was most commonly wrapped around a problem of "action at a distance", in which the nature of the gravitational force was a prime example. Currently, physical science regards their operational format to be involved as "forces of exchange", in which an actual 'virtual' mass-energy particle, which is said to "carry the force" whizzes back and forth in space-time directions via a so-called vacuum to create the measurable strength of that force. That topic is a professional concern of physicists and does not have to be elaborated on here in detail.

13. For homeokinetic purposes, we assume at any systems' level we examine, that these primitive or 'ur'-forces split their directions and entwine and mix so as to produce the higher ordered forms of these forces applicable to the higher ordered, often complex, systems.

14. As a basic example of such higher ordering, consider the chemoelectric or electrochemical force forms that drive geochemistry, biochemistry, plasma physics, and the like. To a large degree, those higher ordered forces are derived from the electric force in vacuum interacting with the split path of the electric force in matter to produce the higher order of 'chemistry' and its hyphenated forms. An interpersonal force between objects such as animals and people is even more complex.

The scope of normal physics and its extension to homeokinetics

15. Starting from Newtonian mechanics in the late 17th Century, physical study was augmented to include: electricity and magnetism, later unified to electromagnetic theory, heat energy and thermodynamics, light and geometric optics unified into electromagnetism; chemistry or chemical physics and atomic physics were then largely integrated in and with electromagnetism; in the 20th Century outstanding defects and new discovery of radioactive chemistry-physics resulted in a modified form of mechanics known as quantum theory linking electromagnetic theory with a modified mechanics for matter-energy that was small and fast, and another form of mechanics known as special and general relativistic mechanics. Physics had reached its professional disciplinary status through those sorts of lines of study. In briefer essence, there is classical mechanics, quantum and relativistic mechanics, electromagnetism and quantum field theory, and thermodynamics.

16. But physics regards itself as being based on or as an experimental science. Its beauty - at least to physicists - is that in its long run, theory and experiment proceed historically apace. As a would-be branch of physics, we accept that fully in homeokinetics.

17. The problem that such a statement creates is whether every homeokineticist has to first or at some point master the discipline of physics. We have wrestled with that problem for perhaps 35 years, in almost every conceivable format. Our answer, still current, is not. We believe it is sufficient to be well trained in any scientific discipline and willing to attend, and that we - through primers and examples - can impart a sufficient technical base to move it into a reasonable homeokinetic based interdisciplinary science. That is the real issue being tested at this conference to add to all our earlier smaller tests.

18. The three running examples we have going now is Penni Rubin's programs in child education in providing children from age 2-6 on upward with a feel and means of grasping the world out there in its complexity, and marvel, leading to possible understanding. Then there is Soodak's Physics 100 course that he has given at CCNY for the past 30 years, for the entire period of open admissions at that school, to the nonscientific student. He is recognized in that institution, and more broadly in New York City, as a great teacher. The third example, is Iberall's experience, running through technical-scientific highways and byways for the past 40 or so years.

19. Physics deals with the forces and collective ensembles of organization, their laws and rules governing motion and change as well as steady states of little or no apparent organizational change.

20. Physics deals with these collectives, most frequently isolatable systems, via a separation into hyphenated applied fields of study. Thus, cosmological physics on top, fundamental particle physics, or physics of the vacuum on the bottom, and many intermediary field, e.g., nuclear, atomic, geophysical, biophysical, even a social physics study.

21. It is fairly traditional in physics, that the professional devotes a considerable amount of a career to perhaps only one, or perhaps increasingly, to two or so fields.

22. What represents the homeokinetic outlook is and has been to supplement the scope of normal physics by what was first regarded as more interdisciplinary combined study, but which gradually began to exhibit a more striking character in a physics associated with nested hierarchy, with an extensive range of time scale processes, a physics for which we began to offer the formal definition of complexity and its complexity measure. That began to emerge in our studies between 1955 and 1980.

23. In a hierarchy of systems in nature, we began to discern the following keynotes which augmented normal physics. As one of our colleagues said - loosely stated - all thoughtful scientists are reductionists, but the true problem remains the detailed path of a constructionist. As a generalist to whom that generalist path comes easy, Iberall and his working colleagues can affirm endlessly the significance of the detailing, which we consider usually emerges from the engineering physics.

24. Most of normal physics does not require our homeokinetic attention. The discipline is (disciplined), it is largely reasonably trained, it has its mathematical and conceptual wizards, its literature is extensive and considerably self-corrective for its errors.

25. There is a residual problem, not only the rather well known residuals in all of the normal fields - one does not need to read a homeokinetics primer to learn of those problems - but of certain areas that have been neglected, those that we have identified as the complex systems with their very long internal factory day delays.

26. By 1975, we began to put a formal catch-phrase name on those complex problems. We associated them with *nature*, *life*, *humankind, mind*, and *society*. Consider them a core of the physically complex problems that the mind and brain (CNS) in humans is confronted with in its intellectual pursuits of each day.

27. At any complex systems level, what we find defining their complexity, is likely a complex of formed subsystems whose association largely exhibits an extensive morphological collective - its space-like properties, and - particularly homeokinetic in character - an extensive spectrum of time-like properties as a spectroscopic collective. Our obvious inspiration for the latter came from the chemical atomic and nuclear spectra used for process identification in physics, or the extensive shake spectrum of processes used in engineering physics structures, e.g., testing a whole airplane, or the even more obvious one of the spectrum for hydrodynamic turbulence, or the dynamic spectrum of vital signs.

28. Another central characteristic of all complex system studies is/was that the field processes, those making up the total hydrodynamic-thermodynamic properties in the field in its spatial and temporal domains, were diffusive and wave-propagative local processes, and - more global in extension - convection.

29. Further, outstanding characteristics of those complex fields were their nonlinear characteristics stemming from the systems' thermodynamics, and minimally from the convection.

30. All fields, at their bottom, were found to be atomistic-like. Thus, as already stated, the key homeokinetic problem is how the bottom collective structure and functions would be connected to the functionally remote character of the top collective.

31. It was possible to prove the following conjectures: That the diffusion process emerged as a collective process in the function of the collective processes above from random walk exchanges between and among pairs of atomistic-like interactions; that the wave propagative process emerged from coherent 'in-a-line' or other extended regular chains of interaction; while the convective global exchange emerged from the replacement of a small thermodynamic regional group, e.g., a cell of neighbors, replaced by a contiguous cell. Further it could be seen that these three types of organized movement or change were exhaustive for their 'directions' of occurrence.

32. Between the more normal physical constraints put on the lower atomistic level in any particular system, and the upper collective-like character of the top level in the system, lies all the intermediate structures and functions in that grand system level. That has to represent a third dynamic descriptive physics. We of course take our cue from a Navier-Stokes construct which is built up from the Boltzmann description. This of course asserts that we really cannot simplify that process more than to say one can either try to follow the mathematics-logic of that process, or take recourse to what we learned from Landau-Lifshitz. You can build up a view of a free energy function for a system from its observational characteristics. If you do that, you can acquire a reasonable sense of the systems intermediate dynamics equivalent to a Navier-Stokes description. While part of the standard statistical physics corpus, not too many people apply it in sufficient detail to grasp the difficulty and complexity it affords the investigator for complex systems.

33. For homeokinetic systems, the problem is exacerbated by the extensive timing and phasing of the various periodic or quasiperiodic processes that are involved. This is further complexified if the range is sufficient to involve quantum states. The detailed problem is to be able to compute and couple the various components that make up real energy, and to determine if their phasing has any meaning, e.g., whether they are statistically independent. In a very important sense, perhaps even a little more complicated than Feynman diagrams, yet with some logical relation, homeokinetics whispers some such sum over states and phases problem, but of a more classical nature. Can we simplify this for a primer? That remains to be seen. So far we have always approached the problem by extensive experimental exploration of the repetitive quasiperiods in cycles, as a hallmark of homeokinetics and tried to see if we could follow the total system dynamics by individual relaxations in each conservation or so-called summational invariant.

34. The study of Feynman diagrams acquaints the student of field processes in quantum electrodynamics (QED) that the path that a field of photons, say, each individually located at its starting point is determined by the path integral of the speed-of-light movement in all available media through all possible reaches through all of space. This at first seems so enormous a task, but as Feynman liked to point out, students learn the art in about two years. It consisted of learning quickly those path integral results that had null net occupancy, and to narrow down quickly on the few regions that would contribute changing motional paths. Thus QED became the sine qua non of results of extreme accuracy in physics.

35. In approaching more general kinds of fundamental particles, as quantum chromodynamics, not quite the same sort of precision is the result. Problems remain.

36. In homeokinetics, with complex associations involved in its atomisms, it is even more difficult for us to characterize the total path integral through all available space-time that a complex atomism will take. Would the reader feel comfortable in trying to characterize the path integral of a complex atomistic system like the person, Tom Jones, running through all the possible adventures he might have to meet head on in London, and England beyond, and possibly Europe, and so forth? Yet there is a possible statistics assignable to the task. It is very likely that the reviewer of Soodak and Iberall (1978) wanted us to tackle that sort of problem as a direction for us to follow then for homeokinetics. At that time we were not ready for the problem, and perhaps we just begin to appreciate its enormity in the complex systems case.

37. One of the first things we have had to realize in the past few years is that we had to throw away dependence on continuum space-time variables. Thus we have had to develop suitable computational canons to befit thermodynamically constrained systems variables at top and bottom, that are discrete. Differentiable function theory cannot be used. We can add up and approximate by simple continuous function over these systems with large numbers of atomisms. So our modeling, in some crude sense, can go down to collectives, e.g., little more than single cells with 7, 10, 20, 100 members. We really do not depend on law of large number averages, for so-called mean state approximations.

38. Because of the extensive makeup of periodic properties and functional performance, we have had to concentrate, in particular, on laws and rules for command-control of states. We regard that as a switching function that has to be regulated in its speed and direction of response. That problem, we consider, operates by a system of chemical catalysts, used dynamically as a language.

39. As a language in what we call a factory system because of operation in many modes of behavior, the language advances and retards the catalysis of messenger chemicals as regulatory chains. The language usage of the system controls its operation by catalysis of switch modes. It can operate in either a wired conductive mode or a 'to-whom-it-may-concern' flow conductive or convective mode. This is as far as we can go in a general description of the extension, transformation of normal physics to its homeokinetic expansion to complex systems.

Vertical and horizontal form-functional strata in homeokinetics

40. To observers, such as us, the universe far outside of us seems to be so far removed that - by any of the signals we receive from out there - those signals seem hardly capable of being the received production of a homogeneous space-time expanse.

41. Thus we gradually infer an inhomogeneous universe out there with a considerable number of matter-energy clumpings. In fact, we tend to find and begin to expect form-functional strata arrayed in a variety of vertical and horizontal segments, also localized in point-like, sheet-like, and volume-like configurations.

42. Before the reader assumes that human complex configurations are the only such possible detectors, note that one finds configurational alignment among other animals, plants, planetary and stellar, and galactic, and small molecular arrays to the signals received from outside. The amount of detail of that mapping may be disputed, but - again - their true story is all in the details.

43. But that state of affairs is not only true for the grand universe outside of each individual atomism. It is also true for the interior of essentially every discrete or bounded complex system. One finds that in us, in other species, in planets, stars, and the like. These two conjectures, or noted observations, or rules, or laws are foundational in homeokinetics.

44. With that assertion, we believe we have established a base for the homeokinetic description that the matter-energy universe out there is a hierarchical system consisting of hierarchical organization as an alternation of levels of -A-C-A-C-, where A stands for an atomistic level and C denotes a collective level.

45. It is the homeokinetic conjecture that such an alternation takes place through all levels in a, our, universe of observation until either a top or bottom level ends as either an A or a C level.

46. At the present, for example, our instrumental observational perceptions (organization of received sensations into perceptions and thence into cognitions, which represent unitarily grouped and named perceptions) find leptons and quarks at the bottom as an atomistic level, and at the top likely a cosmological atomism followed by a detailedly unknown vacuum collective. Professionally, physicists are working hard to characterize that vacuum with increasing understanding.

47. Another detailed feature of that bounding vacuum collective level, is that its detailing can not really be established only by the use of the four common ‘directions’, three space-like and one time-like. So-called ‘string’ theory calls for perhaps ten dimensions of inhomogeneity to understand the total space-time embedding. This is now offered as a substitute for a more compact, more ‘spherical-like’, more near homogeneous universe. But that is all in the professional details that physicists have to fight out. It cannot concern us in homeokinetics. Our physical peers and betters have to resolve those problems. We are stuck with those systems closer to our more sharply perceived levels. And that is another homeokinetics doctrine.

48. Again referring to our colleague’s characterization, we are complete reductionists, of a physical persuasion, but not simple vertical reductionists (e. g., that physics comes out of mathematics, chemistry comes out of physics, biology comes out of chemistry, psychology or ethology comes out of biology, and the like). Instead off to one side, we have the principles of physics, and they connect - by strategies - to the systems in nature morphologically arrayed in nested forms.

49. In an image much like the philosophic view that ontogeny recapitulates phylogeny, we depict the problem in an engineering physics sense. We assert that you cannot run a factory in a compact space and time scale if every component at every level is constituted de novo. Instead you have suppliers at various levels producing and supplying components at varied levels, and it is that sort of upward and outward flow of materials, energies, and subunits of possible function which can run such a feasible homeokinetic universe of systems. If it doesn’t fit, or the production price is too high, in suited time you get rid of it. That is our homeokinetics doctrine.

Systems depicted currently in our embedding universe

50. We need not expand overextensively on the current selections and identifications of the nested systems out there. Once some peoples believed that the systems all the way down were turtles, or others, in a later version, involved us in the

middle and a glass-like remote revolving sphere holding all the star systems, except for a few wanderers. Now, our version is based on much sharper discrimination.

51. A very hasty run through notes:

- a cosmological atomistic level;
- an atomistic galactic level with two major types of galaxies differentiated;
- an intra-galactic inhomogeneous collective of gas clouds, mainly hydrogen gas and perhaps one quarter helium gas, dust clouds containing atomic, molecular constituents manufactured in earlier generations of stars that have exploded in the past; a significant portion of the total matter in the universe in stars that are continuing to be born, live, and die by what is essentially gas dynamic processes - these stars are largely arrayed in a so-called main sequence of stars of different sizes and types as they go through their history, whereupon they die either with a bang or energetically quiet whimper, possibly there is other matter or processes contained in this level which is said to be "dark" (not yet adequately detected) which may carry a larger segment of possibly missing matter or energy (just lately, evidence seems strong that highly abundant neutrinos actually with a small amount of newly detected mass, may make up some or all of that missing mass).
- planetary systems in what we believe to be significant number, at present in an epoch of discovery, are formed as small nearly atomistic collectives among the stars which are produced mainly as binary pairs, secondarily as a star and trapped cold planets, and then lesser configurations;
- planetary atomisms as atomic molecular collectives of cold matter below perhaps 3,000-5,000K which will completely ionize (strip all surrounding so-called electrically negative electron clouds surrounding a positively charged central nucleus) all of its matter - these planets are attached by gravity force to their mother stars and also to 'sibling' smaller moons;
- all of this may sound dull and uninspiring, but the important fact is that the internal hot nuclear chemistry of stars 'burning' represents a cauldron of production sequences that produce a similar range of nuclear-atomic nuclei which make all the elements with stability beyond hydrogen and helium, with greatest abundance up through the atomic weight of iron or nickel, and which results in the production of molecular materials that are connected as carbonaceous materials, silicic materials, and water related materials, and it is that production sequence, properly located in temperature, these particular materials, and a silicic (silicon dioxide - sand) platform like on our sister planets, that is capable of producing life (this is our homeokinetic conjecture and we believe it to be a feasible experimental demonstration as an R and D project);
- the hot nuclear chemistry in stars and the cold atomic-molecular chemistry on planets are involved in the matter collective interactions all through the universe with a common list of feasible compounds, reckoned in the thousands or more among inorganic compounds, and in the millions for so-called organic compounds involving carbon and carbonaceous materials
- the collective of positively charged nuclei number in the few hundred as stable or near stable isotopes of differing atomic mass and atomic number - they represent the stable configurations of collectives of fundamental particles;
- below that are the fundamental particles made up of or as leptons and quarks, in which the leptons are point-like particles like the electron and some nine others, and the

quarks are primitive constituents of the so-called massy hadronic particles such as the proton, neutron and a number of other exotic particles.

- Among the atomic-molecular collectives that we may find on a planet are biochemical collectives that homeokinetics supposes arise and emerge from geochemistry, and thence life (Iberall, Wilkinson, and White, 1993);
- and for out final concern here in this primer, a social physics emergent as a collective process among all - but to us notable - complex systems of life, particularly, mammalian, more particularly, primate, down to our human systems.

52. We did not offer this point as a lesson in physics but just as a quick tour, to indicate that this material does not have to be digested in detail. This is a description at the level of any number of popular science sources. One is not required to mumble through the litany. But neither is the reader to be surprised when some physical consequence of that lower mining story sticks out or forth into our daily lives. It may be a biological process, a virus, a bug, a disease, a chemical corrective or poison, a manufacturing process, a failure of an institution that depends on some such detail. Homeokinetics may have to augment other more standard study by that of its students who are versed in these more arcane lower physical arts, but not commonly, not immediately.

A general summary of the principles governing homeokinetic applications

53. In Iberall and Soodak (1987), we outline ten principles for a physics of complex systems. We believe them still to be a suitable summary for this primer. Assuming a zeroth principle, self-organization must start from modern physics itself, they follow:

Principle 1. All physical nature operates with only a few principles, but they acquire many forms and are expressed in a variety of emergent processes; the basic materials of physical systems throughout the universe are few; natural systems are acted on by only a few forces; the deep problem is to show how historical and evolutionary processes, with their diverse morphologies, arise from the operation of these fundamental elements.

Principle 2. Physical nature operates with only a few types of field processes: diffusion, wave propagation, convection.

Principle 3. A form emerges from interaction between two or more force systems. This process can be described as follows: matter and energy ‘ingather’ (an absorption process), are tied together coherently for an epoch, and then are released (an emission process).We refer to this asymmetric ingathering and release as a hop. The ingathering and release phases of form are unsymmetrical. In composite, the pair of processes represents a hopping Brownian motion, which we regard as a hierarchical version of Einstein’s account of ordinary Brownian motion.

Principle 4. Emergence is a stability transition - new patterns or forms arise because changes of forces and scales make the existing patterns or forms unstable.

Principle 5. The basic physical laws of nature are expressed in terms of formal force systems scaled to the structures on which they act. The creation and stability of new forms require cooperation of two or more force systems, so that form and force systems entwine upon available material collectives and create new forms

of greater size and time scale (e.g., molecules, cells, organisms, stars, galaxies, and societies). This is the principle of hierarchy.

Principle 6. Whereas the physics of simple systems deals with the organized space-time motion consequences (including rest states) of simple mean path-relaxation time movements of their atomisms, complex field systems manifest dynamic regulating behavior, describable in an action-space. Action is discretized into modes characteristic of the atomistic species. The physics of complex systems involves three largely independent phases in a grand dynamic pattern - a start-up phase in which complex systems assemble to make up the field system, a long life phase in which form and function of the field system are maintained by modal actions, and a degradation or dissolution phase.

Principle 7. A recurring ring of action modes in complex systems involves comparable (equipollent) energetics in each mode, with some small barriers between modes. Command-control systems must exist to relate internal and external events. That command-control is catalytic. The catalytic switchings that negotiate the barriers among action modes may be viewed as linguistic signals.

Principle 8. The distribution function characteristic of catalytic switch modes used as language is that of 1/f noise. Communication among complex autonomous units is just barely coherent.

Principle 9. The appropriate scaled physics at each level of organization is thermodynamic in nature (thermodynamics is the physics of 'systems').

Principle 10. Start-up in a system emerges as an S-shaped transition from stable near-homogeneous field I (the flatland of lower atomistic structure, which generally will contain homogeneous regions at its scale, such as gas or dust clouds in a galaxy out of which stars form) to stable near-homogeneous field II (the flatland of the higher level, e.g., a local community of stars).

Additional principles derived from key homeokinetic applications

These final five sections will be very brief sketches of major problems under each major topic that homeokinetics feels competent to undertake. They are then also used to infer additional homeokinetic points to add to this primer.

Nature

54. Saga of the grandfather clock - continued (Iberall 1997a, p.237). This is a continuing but simplifying demonstration in homeokinetics of a low dimensional mechanical-thermodynamic 'dynamical system' which is not chaotic. It consists of a simple compound 2 second pendulum suspended on a hanger under a nonlinear pendulous escapement that draws a week's worth of gravitational energy from a chain carrying a mass which 'falls' in the Earth's gravitational field tick by tick as that tick-wise fall is released from side to side by detents.

55. What we have done new for this primer report is to interrupt our year and more long experiment. In that experiment, the clock with escapement has been gaining about 21 seconds per day at the current small nut-determining effective length of the pendulum for the past number of months in an autonomous time keeping mode. We have then rewound the clock by raising the weight every 7 days, discounting one day to permit

the escapement to find each time its new phase, but using the cumulative time-keeping statistics of those independent 6 day epochs, which have averaged about 126 seconds gain per 6 days.

56. Our interruption has been to make a pendular length adjustment to some gain or loss per day closer to zero, and then to point out very simply what our tests and statistics have revealed. We can then ask the reader whether they are satisfied with our demonstration of no chaos and the generality of our demonstration.

57. Clearly, we will claim the following time scales and processes in our near-autonomous system. There is the 2 sec pendular time scale with some nonlinearly determined spatial travel amplitude. There is a higher frequency small seismic signal of under Richter 3 magnitude - see Cal Tech reports every time they are called upon to show a shaking for the general region; loosely speaking the energy is centered in the fractional sec time scale of frequencies; under higher seismic excitation, the pendular system exits from its simple near planar mode of swinging and goes through some wilder mechanical gyrations because of the very poor hanger suspension design, but it soon settles down back to the more nearly one degree of mechanical freedom motion. The mechanical gearing to the 12 hour one revolution clock period creates a second or third major time scale. We use and report it as the composite of two such periods, effectively the solar day. The clock knows almost nothing about the day, so that its motion is nearly simple pendular, being compared with a more absolute time keeper of NBS/NIST time which is now stellar, planetary, solar, and atomic in its total scope. We make two demonstrations of these theses. The pendulum and others like it have been tested hundreds and thousands of times at random and have shown their near isochronous pendular mechanical movement in a one dimensional response. For the sake of ‘proof’, we once again have tested our pendulum at amplitude levels from a standing start below the escapement coupling level to show its nominal isochronism, i.e. by counting swings per NBS/NIST time with a sufficiently accurate transfer clock. Second, we have shown that the pendular swings decay in angular amplitude in an exponential fashion proving linear thermodynamic loss. The major source of that ‘damping’ loss is the boundary lubrication in the support hanger. The proof of that is that the clock has to be oiled before some time like a 5 year period, otherwise the motion seizes and the clock stops. Other losses come from the gearing. Thus at that point, the clock continues its period swing to period swing by the coupling with its escapement to produce either the daily cycle or a hidden cycle connected with the Q (quality) of the decay process. We determine the Q and that time scale by counting the number of swings before the clock comes to a halt or some fractional decay per near-isochronous time scale. By such counts, we find about 50 - 2 sec double amplitude swings, 100 sec worth of swinging with no escapement ticking. By observation of the small dial which enumerates the 60 ticks that make up the indicated escapement movement per 60 sec base cycle, we can observe the discrete escapement dynamics. Here it is very clear that the escapement is poorly designed. Instead of getting clean 60 ticks per minute, that dial indicated slips, stops, stutters, even if the entire cycle in invariably repeated. What is clear that after rewinding the clock, namely changing the phase relation of the escapement to the swing pendulum, there is another time scale representing that time it takes for the escapement to find its commensurate or coherent weakly coupled process to the swinging pendulum’s phase (at present, we believe that upon rewinding the escapement chain, the escapement delays its impulsing by about 13 seconds in the next few minutes, with essentially no interference with the pendulum beat, so that indicated time of the small

escapement dial falls behind that amount of indicated time for the next 7 days until the clock is rewound; it has taken us a long observation time to grasp that the loss was not spread over the entire 7th day of winding or even a few hours, but effectively all in a few minute revolutions of the escapement cycle and its drive for the geared clock hands. We have no desire, at present to account for or to redesign the escapement) .

58. Out of this complex of time scales, including an unregulated outside temperature, even a very small barometric pressure scale of variation, we can report of the following. With the transfer means we use - in a time window early in the morning, half stumbling in the dark, it is difficult to note time coincidence for periods shorter than 1 sec, or at best with a glimpse of a half sec resolution. Thus our fastest time scale of observation, the number of seconds change from day to day has a statistical error of about a sec or two. We record our data as the number or seconds change from day to day. Thus a time sequence like 20, 24, 22, 27, etc. As we have said the precision error of those reports may be a sec or two. The statistics of those data have a distribution that is nearly a standard or usual truncated Gaussian error form with a standard deviation of about 1.8 sec. In particular, we use the cumulative form of the distribution to estimate the mean time scale and its deviational characteristics. Thus the linear isochronous clock trend and its variance would be reported as about 21.8 sec +/- 1.8 sec. That is the statistics for the individual daily cycle. It agrees with the measurement precision and really has no surprises in it. But then we are also able to demonstrate the 6 day average, which we have imposed because we have to wind the clock to restore the energy, and because of a poor and limiting escapement design, we have to interrupt for a 7th day not to introduce a very peculiar phasing error from the escapement (we call it a daily slitching error for that one 7th day). That is not what a simple correct escapement should do. We could handle it by a second similar clock wound out of phase by 3-4 days from this clock to carry us over the day of winding change, but the story is transparent. Our six day statistics is similarly truncated Gaussian, and centers around 126 sec loss with a variance of about 126+/- 1.8 sec. Thus we find the second result of about 21.8 sec daily gain and a variance of about +/- 0.3 sec. and that is very striking. It is indicative of no mathematical chaos for this low dimension nonlinear mechanical-thermodynamic system, simply a Gaussian or Maxwell-Boltzmann statistical physics distribution function. With our new pendular setting, all our preliminary tests lead us to believe that we will achieve the same precision in our variance. Having taken a day to adjust and estimate the trend we have succeeded in setting it to less than one second gain or loss per day. Now we have to take weeks to find out what our trend and variance really is over the 6 day week data statistics. We have little doubt (now none) that it will be very different from +/- 0.2-0.3 sec per day. Our results are not incomparable with the NBS/NIST derived value for g, the Earth's gravity, of 980.665 cm^2/sec with a variation of about 1-2 units in the last significant figure which was done in the honoree's laboratory by an earlier occupant from whom the lab was inherited. This part in a million variance was achieved from a much more thoughtfully designed pendulum and escapement.

59. Are there new homeokinetics principles? Not really, except to stress how important it is in a Bridgman sense to have a rather full idea of all the essential time scales that you need understand in a complex system; that mathematics is not the same as the physics, that lots of things exist and remain in the engineering physics; that you most often will have to pursue both a continuum-like and a discrete-like mathematical description; that you will always be safer if you integrate and compare, rather than attempting to

differentiate; to watch out all the time for hidden variables, and - as the most stringent part - while you may continue to build on the back of others, you very often will have to depend only on your own first principles' study to find out who is telling the truth; also be very willing to find yourself wrong.

Life and its speciation

60. Rather than being a specific homeokinetic point devoted to life and speciation directly, this point will offer a description of a very simple element which can serve quite generally to urge [to force or impel movement in an indicated direction] a thermodynamic engine from mechanical parts and which is quite possibly an early forerunner for the evolution and development of a great number of Nature's self-organization of forms and functions, even complex ones. The unit considered is the bang-bang or oil can oscillator - a homeokinetic oscillator of some generality.

61. Human mind, as does Nature (both complex systems) operates by a peculiar fumbling mode which we have identified and named in homeokinetics as reverie (lost in thought in that CNS known as mind). It suggests that each such ex- or incursion has its typical space and time action of coursing.

62. Here we wish to put forth an energy storing nonlinear element that - if it finds itself coupled by accident (or 'design'), furnishes the basis for a common oscillatory system.

63. The element is a bistable elastic element, one that was used by Euler to illustrate the instability of the buckling column or strip under axial load, and by Poincare in the snap action plate under edge compressing load in the plane of the plate. Simple illustrations of immediate demonstrability are a thin rod or strip, cover of a packet of matches, or the like. Involving further preparation is an oil can bottom. The snap motion is found illustrated by rods, strips, plates, shells, etc., put into such fixed compression at near a critical point of strain-energy stored mechanically in an elastic volume. The energy to snap the element in a direction of use from 'stable' position I to 'stable' position II can be made very small.

64. To complete a simple form of a mechanical oscillator capable of delivering power, we will illustrate one that we tested and developed into a power tool. We took an oil can, affixed a power delivery rod external to the snap diaphragm, cut off much of the spout and threaded into the remaining internalized spout section a valve-containing block consisting of a discharge orifice, an internalized and guided ball valve attached to a long rod that could reach internally to the snap plate when the ball and rod were pushed through the orifice and seated on its beveled lip, and a conical spring mounted on the external face of the block to put inward bearing sealing force on the ball valve against its seat. If the diaphragm was not in contact with the rod, the ball was pulled down into its valving seat closing off the oil can chamber. If the oil can bottom was snapped down, it would deflect the rod and ball assembly into an open position, opening the oil can chamber to leakage in of air into the can volume. A vacuum pump source was affixed to the side wall of the oil can to creates suction in the can to cause the can bottom to snap inward. The flow rate of the vacuum source and the oil can chamber would determine the rate of restoring a critical suction at which the oil can bottom would snap and open the rapid inward leaking of air into the oil chamber. At that point the outward mounted power rod could deliver a hammering power impulse, like a jack hammer to an outside load, e.g., we first demonstrated that it could hammer in thumb tacks. We then developed the principle

into an air tool like a jack hammer. This is a thermodynamic oscillator or DC to AC converter, taking energy from an air supply and converting, by a nonlinear escapement-like device, into a mechanical energy elastic energy power impulsing stroke. It is not meant to be spectacular, just insidiously general, homeokinetic, e.g., as an additional hand held power tool for shaping metal. Part of our definition of a complex system, in explaining the meaning of its language, is that it represents a tool used to augment the flow of action. A tool was defined as a material-energetic entity, neither self nor outer world, which could be interposed between self and outer world to augment action.

65. Generalize it into many other forms. Consider any other continuing flow source of energy, e.g., a human who eats regularly metabolizing chemical food energy to energy and store available source energy in various storage bins - muscles, liver, and the like. Consider that he or she is a nonlinear marginally stable storage source who can self-urge those sources he/she carries into an almost nondenumerable number of directions (e.g., he/she does not even know how to count them all unless confronted by many signaling scenarios). The body can then snap into a direction. It does that in stock market decisions, by elites or ordinary folk who have to make important or trivial decisions all the passing time, by people who are always taking one or the other or binary decision mind sets, e.g., to trade or to rob, to persuade or to rape, to buy or to sell, to be or not to be, to kill or not to kill, to eat or not to eat, to scratch or not to scratch a body itch.

66. Get simpler, go at it at the very beginning of the life process, or at the time of any transition, e.g., even as speciation development or evolution. Think about the very primitive chemical links and chains by which nonlinear chemical steps or processes emerge from any streams of energy flow. It becomes 'mere' homeokinetic exercises to work out feasible urge paths. This is a primer, so think further. If any one such step is entrained and encoded, an organism can diversify and use that one step as a base for further development of interacting or synergetic engine processes and let complexity truly develop by homeokinetics. That's the foreshadow and the forecast.

67. We have arrived at an even more striking illustration of the generality of what we are discussing here. Consider first a current bit of standard physics, the demonstration that neutrinos have likely been shown to possess or exhibit mass, as well as energy. If true, the large number of flux of neutrinos may account for some if not all the missing mass in the universe that most physicists would like to find in place to make the cosmological modeling task simpler. The problem has merely occupied physicists perhaps 55-60 years at least for the time since the conceptualization of the neutrino. Those studies do not need homeokinetics. However the analogous problem in complex systems, such as living, on to human, is somehow trickier. That problem, similarly can be stated by the depiction of two mass-energy atomistic-like particles passing each other with very weakly interacting forces whose complex character we do not quite understand yet (they are not new forces, but complex entanglement of the known forces, and capable of becoming saturated or shielded by having to engage in too many force bondings). The question that concerns us, in a homeokinetics sense, is to what extent might there be some mutual entrainment, some more permanent mark left after the passage. That is a key homeokinetic problem in a dynamic impulsive sense. We have enough reason to believe that the effect of such encounters may be zero; minimal and trivial; momentary; lasting, but fading; lost in memory banks, but lasting tucked away as one more long term memory stored out there, without cluttering up the memory banks. The newspaper of the day has two modest but spectacular illustration of the fact that - in what we view as the 6 sec stream of cognition,

going on as 15,000 signaling bits per day, in which the interperson interactions involving that persistent scaling provide very little bonding unless they are spectacular or persistently repeated - with almost only noisy passing interaction, happenings can occur. The first, Sun., June 7, 1998, *LA Times* pp. A1, 28, 29, presents the story of how a judge in Orange County, 4 years after the county had been driven near bankruptcy, orchestrates a $400 M settlement from Merrill Lynch's super attorney, expressedly hired to avoid any such settlement, and a weak team of county attorneys but also very persistent, manage both to be bent into the shape, one lawyer against one lawyer, by the 2 year orchestration of one judge. The passage of the two lead lawyers had no direction of such lingering action influence attached to their compulsive meetings. The second, pp. B8, 9 R, the day before in the religious section, relates to the reintersection for the past 20 years of two Christian faiths that separated permanently 450 years ago - the Protestant break over doctrine led by Luther, from Mother Catholic Church. The issue was whether one accepts only belief in Jesus Christ as the condition to go to heaven or whether good works while living are required. By last year, the American Lutheran main body had arrived at an accord, said to be accepted by the Pope, as a "Joint Declaration on the Doctrine of Justification" (we and Hassler have that reported on in our forthcoming book on a quantitative social physics), and this year June 7-18 a more final and complete accord is/was to be struck in Geneva among all the rest of the Lutheran branches. Twenty years of persistent hammering by representatives of both organizations, complex systems, have been devoted to find a path, a direction of common agreement. You may regard it as peculiarly a human intellectual exercise; we regard it as homeokinetics, a higher ordered chemistry of the CNS, or a command-control system in any complex system. More compact space-time interactions, intersections take place in elections. We mention them later on.

Humankind

68. Humankind constitutes one species of living organisms. They form a collective known as sapiens sapiens. Phylogenetically, it is a collective nested among a higher collective, the genus Homo, who are nested among the family of hominids, beyond are hominoids, then anthropods nested among the order primates, up into the class of mammals, then as vertebrates who are nested among primates, who are nested among the phylum of chordates, who then belong to an association of three kingdoms that Woese - whom we and others now accept - has identified. The evolutionary, developmental, diversification of this fantastic complex of chemically emergent forms is the great challenge of the past and present century, and remains for further completion in the next century, or millennium. Our very small homeokinetic contribution may be followed in (Iberall, Wilkinson, and White, 1993) and what is yet to come as a biochemical foundations model built on a geochemistry model. What do we choose to illuminate here? We propose to at least give you a sense of the problem that we were tackling in (Iberall, Wilkinson, and White, 1993) as an introduction to the evolutionary problem. In one sentence the problem is how to resolve the problem of evolution in the difference between a so-called punctuate form of widely separated time scales and a more nearly near-continuous record of producing and creating diversified species. That controversy goes on very heatedly.

69. For a story of Mankind or Humankind, we suggest to the reader two different descriptive sources (Young 1971, de Laet *et al* 1994). One is older, the other quite recent, but their authorships differ greatly, even if they both are masterful. The first is

written from the point of view of a neurobiologist with wide learning; the other is written from the point of view of two handfuls of world dispersed paleobiologists and paleoanthropologists organized as a second group effort under UNESCO sponsorship. We regard both as being quite authoritative. What homeokinetic inferences do we wish to draw? First, besides a somewhat common body plan and brain command-control organization at say the mammalian class (see for example Havez (1962) or see Gerstner (1992)), their phoneme language of dynamic fragments and their organ chemical functions and catalytic languages are generally quite similar. Second, this is even more specialized and common at the primate level (see, for example, the ethologist, Eisenberg's two articles on their common behavior). Above that there is even greater commonality at the hominoid and hominid level even if the latter is more inferential. Here we recommend de Laet *et al* (1994). So we effectively have to look at an almost last branching at perhaps 300,000 ybp. In principle, we can essentially imagine a relatively common branching in form and function as of that scale from very close relatives of the Homo erectus nurturing species, and an almost irrelevant branching off of Homo sapiens neanderthalensis. There are some more modern details which can interpose one or more subgroups at that junction but they count for little, except a modest number of point mutations. So what do we find at that sort of junction for the range or litany of dynamic behaviors?

70. We find the small group band structure that will persist almost unchanged over the next 300,000 minus 10,000 years. Humans by then were superb hunters (the now known record of spears with hardened points), and gatherers. We already know of a 3,000,000 year history of evolution of stone tools at what can be estimated is a rather uniform rate. Thus that Homo brain structure and function was already on a modern track rate. If one tracks an incrementally changing level of tool development, at what we call an adaptive steady rate to the emergent exigencies, one can see it keeping track in its dispersing rate with changes in the chemical-physical environment. We trace all this sort of modeling in our new book.

71. If one looks at such books as Chapple and Coon 1941, Service 1958, Service 1963, Harris 1968, Polanyi, Arensberg & Pearson 1957, or our colleague's Moore 1992 which already has an homeokinetics bent, then one grasps Murdock's *Ethnographic Atlas* (1957), which offer statistically standard behavioral patterns in all primitive cultures of band societies under a few hundred in localized population (clustering densities of less that 0.1 to 1 person per sq mi).

72. This life style brings us up to about 40,000 ybp, without any significant break. Thence, from 40,000 to 10,000 ybp, there is steady population growth at a constant rate and density (more area of the Earth's surface becomes included in the pattern. One can say that the low social vapor pressure is climbing somewhat as the rural density stays nearly constant, but the small clustering concentrations increase the more global density). At 40,000 ybp, there is a cultural stability transition.

73. The technological rate potential makes a transition to a higher order of catalytic language complexity. Abstractions as represented in art and utilitarian functional forms begin to emerge. Those emergences, in a common language are 'stands for' or complex representational forms. These are the Venus figures and other denoters of a more abstract language. In a homeokinetics sense, we conjecture that another intermediate layer of neurons have evolved which have the extra capability to be used as denoters, an added language level to the many that already exist. One might say that the person now 'knows that he/she knows'. Why is that language possible or appropriate?

74. Because, as Darwin began to explore, now examined with greater depth and care, one can test psychologically what types of information primates of various levels can recognize - things, markings, signals associated with their bodies - in mirrors or other self-referrals, and one can see the level of growth or change in that depiction. This literally is 'monkeying' around with what is inside that can recognize both material outside and inside, and it is a form of Feynman signaling that we refer to elsewhere. There is a change as of 40,000 years ago and in the representative nature of the new artifacts associated in number and viewed as complexity in cultural artifacts from that time on.

75. In our new book we trace the development of cultural artifacts and technological gain in amplification of action from that time. It is no surprise that the cultural developments segue into the use of vegetable, animal, and mineral resources, and their amplification by more overt languages for control of group behavior.

In any case, by this sort of schema, we manage to trace and predict and account for cultural, demographic, material, energetic, action streams by which humankind develops, first between 40,000 ybp, then up to 10,000 ybp, and then into rather recent times. We take note of the break as the so-called demographic transition and bring our story both predictively and retrodictively up to the present. But all that sort of 3 years of detailing does not have to be all laid out in a primer. Suffice it to be a forthcoming prospect as soon as we are able to finish.

Mind and brain

76. Saga of human command-control. We propose to show, by homeokinetic arguments similar to those for the clock, and to the Feynman program in quantum electrodynamics (QED)[1]. In the clock, we had only to consider the interaction back and forth of a pendular system and an escapement system in an external gravitational field. Here now, we wish to examine the scattering, propagation, by means of interactions of the person with inner and outer escapements, entrainments like our hopping Brownian motion, bonding and force repulsion, also with external fields. Why in Earth or heaven, or any other reach of space-time would we possibly imagine that we can treat or handle this by homeokinetics?

77. The honoree has written a number of papers for the ecological psychologists, and has identified a considerable number of time scales in the process (Iberall & McCulloch 1969, Llinas & Iberall, 1977, Iberall 1992, Iberall 1995, Iberall 1997a, Iberall 1997b, Iberall & Wilkinson 1997). These papers start to build a base for a homeokinetics spectrum in the person, in mind and body, both as processes and forms that deal with the instrumental view of those chemical-physical functions and forms. That modeling goes from the senses and sensations in the body (basically of all mammals) at the sensory organ receptors out to a few tenths to 1 or 2 seconds, then to the integrative perceptions which unite a sheaf of sensations into a unity at the few seconds level. At that level in the hierarchy of awareness, the cognition is formed as a command-control selection or choice of which of the signaling perceptions throughout the entire body gets the attention. That is quite well up in higher reaches of the brain. Operating in the 1 to 10 sec range as a

[1] For the forewarned, the simplest glimpse for gleanings of the latter may be found, say, in (Lerner, Trigg 1991, pp. 380, 969, 974). As the first article author starts out, "Feynman diagrams... are graphical representations of ... theory involving the scattering and propagation of interacting particles". In QED, only electrons, positrons, and photons are involved without external fields, but we have to integrate our answers over an entire universe of 4 dimensional space-time fields.

persistent stream of about 6 sec average mean time signaling complexes, it represents an almost continuous flow of about 15,000 streaming signals that are constantly forming and telling the organism's ongoing story. That level (see Gerstner, 1992) constitutes the phonemic level of signaling in effectively all mammalian CNS systems. The fuller content of languages - in our conjecture - begins at the level of various kinds of chemical processes, both wired in the nervous system and conductive to-whom-it-may-concern signals, e.g., neuroendocrine, in the blood. Through the faster endocrine flows, one finally gets to the slower time scales, some species' dependent, others not, until one gets to about a 3 hour time scale which seems to be chemical thermodynamic closure in the person's organism. Beyond the 3 hour scale, one gets to time scales and processes that are more related to social physics and chemistry. Iberall has pioneered in that subject in an extensive literature, which can begin to be pieced out from (Iberall, Wilkinson & White, 1993)

78. Given that there is a continuing extensive spectrum out to the life span, such as near 100 years for the person in human demography, and beyond out to 500 years for civilization, and then beyond to speciation throughout a 3.8 billion year (Gy) epoch, what do we learn about the intermediate time scales that represent the scaling and effect of command-control as we ordinary observers of ourselves might cogitate. The present period in history has been very informative for new ideas of an homeokinetics nature for that scaling. View it as follows. We will try to put together our so far known and conjectural base in the depiction. Heretofore, as in (Iberall, Wilkinson & White, 1993, Chapters 4 and 6, particularly pp. 146-148), you will find our characterizations very vague, even if on track in a musical orchestral sense. A static view of the true neurochemistry, as chemical languages, in the mammalian brain has just come out in the work of one of our homeokinetics group, Dave Jacobowitz (1998). It will take readers perhaps the entire next decade to grasp the full import of that book and its contents. The study is no longer easy. The gap between the atomistic level in the nervous system, e.g., as one might find it in Higoshida *et al* 1993, or the classics like E. Crosby or Scheibel's work is enormous.

79. We offer a caricature for such a process of formation of an evolving human 'personic' group scenario of some significant sheaf of autonomously organizing dynamic trajectories. It may begin from starting impulses of a political person, or clique, or clan, or spin doctor, or advertising executive, or political move to start a war, or change a belief system, or to create a lynch mob, or the like. Thus a new idea or thought is thrown out, e.g., it is picked up in a public medium such as the newspapers on its first day, or leaked into a reporter's ear. Within the time scale of two days, opinions begin to form about it. An elite leadership, who want to take some control of the movement, generally has to react in a few days. By about three days, there begins to be a social division for or against the idea. Regardless of how or why they may accept or reject the idea, there begins to arise a feasible conductive constituency for and against the idea, in percentages of about 20-40 percent for, and similarly 20-40 percent against. Anyone who explores the rationality of this so-called sapient species alignment is in for surprise or disappointment. There is nothing rational about it. It literally is an emergent neurochemistry related to chemical behavioral formation that developed in childhood in perhaps the first month or two of infant nerve formation. We have tried to trace it through a Freudian lens (e.g., 1949, 1954, Outline and Origins of Psychoanalysis; Projects for a Scientific Psychology) and its various derivative followers. We have explored his teacher's - Charcot - library at Salpetriere for turn of century writings which led to an engineering and scientific theory of

communications and command-control, in all ancillary fields. Even though a theory of information flow did emerge, its connection with the neurosciences has not been there. We are partisan enough to believe that Jacobowitz' effort can finally get us there in its pursuit of the chemical architectonic languages of the brain. We tried hard to bring our friend Paul McLean in time for our conference to help outline the path. Continuing the scenario, the remainder of the society that cannot make up its mind and take a stand, perhaps 20 percent, sometimes more, furnish the swing vote that the leaders of the organizing group and/or the elite leadership in society, or the opposition, have to try to win over. Again, there is nothing rational in their effort. They find and explore all propaganda or emotional or monetary or reward means that they can to influence the swing group. Picture the incessant stream of 6 sec phonemes, 15,000 a day crossing individuals minds. In about 30-60 days of such signaling some bias begins to be put into the organization of mind paths. But as directors of polling organizations state, there is no settling down of outlook until about 6 weeks before an election or choice has to be made. Do you accept this depiction or not for the intermediate time scales, as an orchestration of the various clocking processes that go on in brain structure and its mind function through only neurochemical processes?

80. What is novel to our current learning from the current period is how empty, how divorced from any real attachment the human person has to the true value of his/her ideas. There appears to be a great deal of passion, but it is empty, devoid of human attachment. We have derived this by noting the difference between attachment to conservative or liberal ideas of operation and the extreme wing attachments to what are effectively religions and cults. This is one of the most mixed up periods in all of 10,000 years of civilizational history (See *LA Times* 6/21/98, on Religion in America). Note, for example, in the Monday June 8, 1998 *LA Times* an article about the Southern Baptists trying in rather large numbers, as evangelics, to proselytize Mormons to give up their Latter Day Saints beliefs in favor of the rigid Baptist Christian views. It is at least as ridiculous in America as the Jews for Jesus movement, all designed to destroy the American freedom of religion (or nonreligion) that helped create our Constitutional view of Governmental command-control. We simply cannot afford to take a stand yet in our physical belief system on what this means for homeokinetics theory. It has to evolve yet in our thinking. As a measure of that empty punditry that we currently have been confronted with by our national managerial elite for the past generation, perhaps as a metaphor, when we attempt to winnow out the direction that a summation of the current existing events seem to suggest, at least to us, if things are going well we get the response "Don't bother us with such a pessimistic picture; the sky is the limit". On the other hand, if times are currently bad, their reply is "Who cares about what may happen, the bottom is falling out of things". This pair of responses we characterize by the assertion that the common judgments are orthogonal or very nearly so to the course of historical truth. And in that sense, we find it very difficult to work for most managements.

81. So what have we learned as new homeokinetic principle points? Clearly our concept of parallel small energy catalytic languages and power chemical processes at every complex system layer has to be true to provide any organizational stability. Our existing stable systems have to be many layered, and subject to multihierarchical control. And that control has to be free of affective organized content. We operate with a broad panoply of feasible chemical directed emotions, and they just ripple over us from childhood formations. It is not the libido of sex, or power, or the like. It is some sort of coherent

language structure which we each use. It differs from everyone else's, and/but the others think they understand it but they don't. Yet it works good enough for governing purposes. Iberall has detested that sentence since he first went to work for Government in 1940. It is with a great shock that he finally stumbles on its intrinsic truth in the general case of complex system command-control.

Society, particularly human

82. The saga of trade and war in human social history is civilizational, with technological augmentation. The homeokinetics comments here are formed from work done with Frank Hassler, a nuclear physicist with the Department of Transportation, and with the homeokinetic development and evolution of a social physics work done through The International Society for the Comparative Study of Civilizations (ISCSC). Hassler and Iberall have been working for the past three years at a book that offers a quantitative model of civilizations and their operational dynamics.

83. Human persons are integrated into civilizations and their precursors for the past 18,000 years. The emergent form is a locally dense population of persons organized into urbanized settlements within a sparser more uniform rural population. The centers of concentration are bound into collectives of perhaps a few hundred miles in compact area, and the broader collective of such politically bound units (politics refers to the highest local order of command-control by some sprinkling of elite or high energetic leaders) interacts weakly or loosely into what is referred to as an ecumene of such political units. The main processes that govern this complex array - it is complex because of the very extensive memory function that is involved in its persistence - are trade and war. Why? Because the total flow of materials and energy cannot be provided only by pair by pair interactions, or small group interactions as had occurred earlier than 18,000 years ago as hunter-gatherer societies. But the match, in such flows and their mismatch at a time scale of the human generation, tended to guarantee the dissonance of war (see, for example, Iberall 1973). Beyond that local process, the match of some such collective configuration, like the earlier hunter-gatherer small band configuration which would come apart and reform anew every few years, here with some greater stability furnished by more nearly solid state institutions and a social memory, and a persistent technological flow as a rate potential, resulted in achieving a stability more like 25 generations, 500 years.

84. With no room for doubt, as physicist collaborators, we recognized the process as a vapor phase collective operating under low vapor pressure - the low density rural population, with condensed liquid droplets - the collective urbanized centers, which in time would evaporate and reform. At the same time, within the condensed droplets there would be institutions of more nearly solid plastic form, some as organs, others as other chemical impurities or material forms partly restrained in motion by stronger than liquid bonds.

85. To avoid this appearing metaphorical, consider the architectonics of a house. Here we ask recall of Jacobowitz (1998). A house looks like a solid structure, commonly in some early mythic period of its ownership. As time goes on, repair and replacement represent a near continuum-like flow of materials, costs, and action streams to keep it working. To the maintenance engineer, it is a steady flow process from the very first day of operation. The process in architectonic, not simple architecture, a one shot construction. That is a very homeokinetic principle.

86. With Wilkinson, as political scientist, and our homeokinetics group in the social sciences for the past 15 years, organized under the name of PUSS, Physically Unified Social Science, we have met and worked together and even taught together on a number of test occasions, as part of a search for common principles and language. From that we have uncovered quite a few homeokinetics principles of some additional interest. We add these here.

87. For example, as large structure social time scales, we have identified the time scale of 4 hours as the top scale of biophysical organization of the individual person, the scale for chemical thermodynamic near equilibrium. Thus work organization, restaurants, and the like illustrate social attention to that scale. Then there is the Earth day, whose daily night-day forming process accounts for the social regulation, e.g. by mayors, of that scale. Beyond that is the 30-60-90 day scale related to seasons and mood and mode changing. A society based on agriculture and animal husbandry finds it necessary to attend to that scale through all its operating activities. The next integrative time scale is the solar system year, which binds the seasons and all the trophic webs on the Earth together. Corporate entities tend to do their system accounting at that scale. Beyond, hastily, is a 3-6 year scale that tends to represent scaling for the political command-control, and with some added complexity for the economic scaling of the very general trading process (and/or war process, for example governed by a focused question: Is it cheaper to trade or to rob and pillage). We can then pass through the life death process of demography which deals both with a generational scaling - passing of the guards task, on through the one or two or three generation life scale. And so we finally arrive at the 500 year or so life of civilizations scale.

88. In and among that very extensive quite dense homeokinetics social spectral scale, we also find those process lines that accentuate the trade and war saga. Thus, introduced to the theme by the Foundation for Cycles (Dewey), this person has pursued and sharpened up data and causality for a generational scaling in near periodic process of war concentrations in the general ecumene for the past 2-3 millennia. On the other hand, Wilkinson, following the lead of the Cambridge hydrodynamicist Richardson's *Cause of Deadly Quarrels*, has sharpened up the study of an approximate 4 or so year period in smaller wars within ecumenic groupings. In ISCSC, we have helped pursue these questions with the Society for the Study of Peace. The point is that within all these societies among which we have interacted, it was quite useful that we could offer a physically based scientific account, and then begin to carry it further to help them to a reasonable based science for their general fields. Thus in our view, a physical base for trade and war is an essential ingredient for understanding a human social physics.

89. But beyond that, we begin to contend that this concept is more general for all complex system collectives and their societal or collective dynamics. There always exists the possibility of some form of strong and then weak binding, through a process of saturation between pairs of atomisms. And that then continues to raise a stability question. Should a next binding take place to the one unit, or to the few units, or to the many units. That sort of question really originated with Aristotle as a political question, and it still remains a physically based political question. Who rules? Hassler and we pursue this question now as a theory of the elite command-control.

90. At the very last moment, we were forced (late in 1998) to add this very serious extra point to our homeokinetic construct. It is in our paper, What Makes Sammy-Samantha Run? in *Ecological Psychology*, 1999. Narrowly, it means to deal with

command-control among humans; more broadly, it refers to that process among all complex systems. By this time, we have looked at the problem from the point-of-view of all of the following incomplete list of academically recognized disciplines: psychologist, psychiatrist, ethologist, ecologist, biologist, physiologist, pharmacologist, neurologist, neurochemist, biochemist, physical chemist, anthropologist, sociologist, politician, economist, lawyer, priesthood, religionist, philosopher, logician, physicist. We have used the general concept of a 'value' system as a or the potential driving command-control. While we have made some progress, homeokinetically, with that study, it still is far from complete or yet adequately determined. We cannot say whether it will ever be. Our fundamental belief or hope is that its complete ultimate reduction may take place in and by a hardnosed science combining pharmacological and physiological neurochemistry, and biophysics-biochemistry of a systems' homeokinetic kind, but this may be a false hope.

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