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REPORT NO. DOT-TSC-OST-76-12.III

SYSTEMS MODELS FOR TRANSPORTATION PROBLEMS  
Volume III: A Computable Command-Control  
System for a Social System

A.S. Iberall  
S.Z. Cardon



MARCH 1976

FINAL REPORT

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VIRGINIA 22161

Prepared for  
U.S. DEPARTMENT OF TRANSPORTATION  
TRANSPORTATION SYSTEMS CENTER  
Office of Systems Research and Analysis  
Cambridge MA 02142

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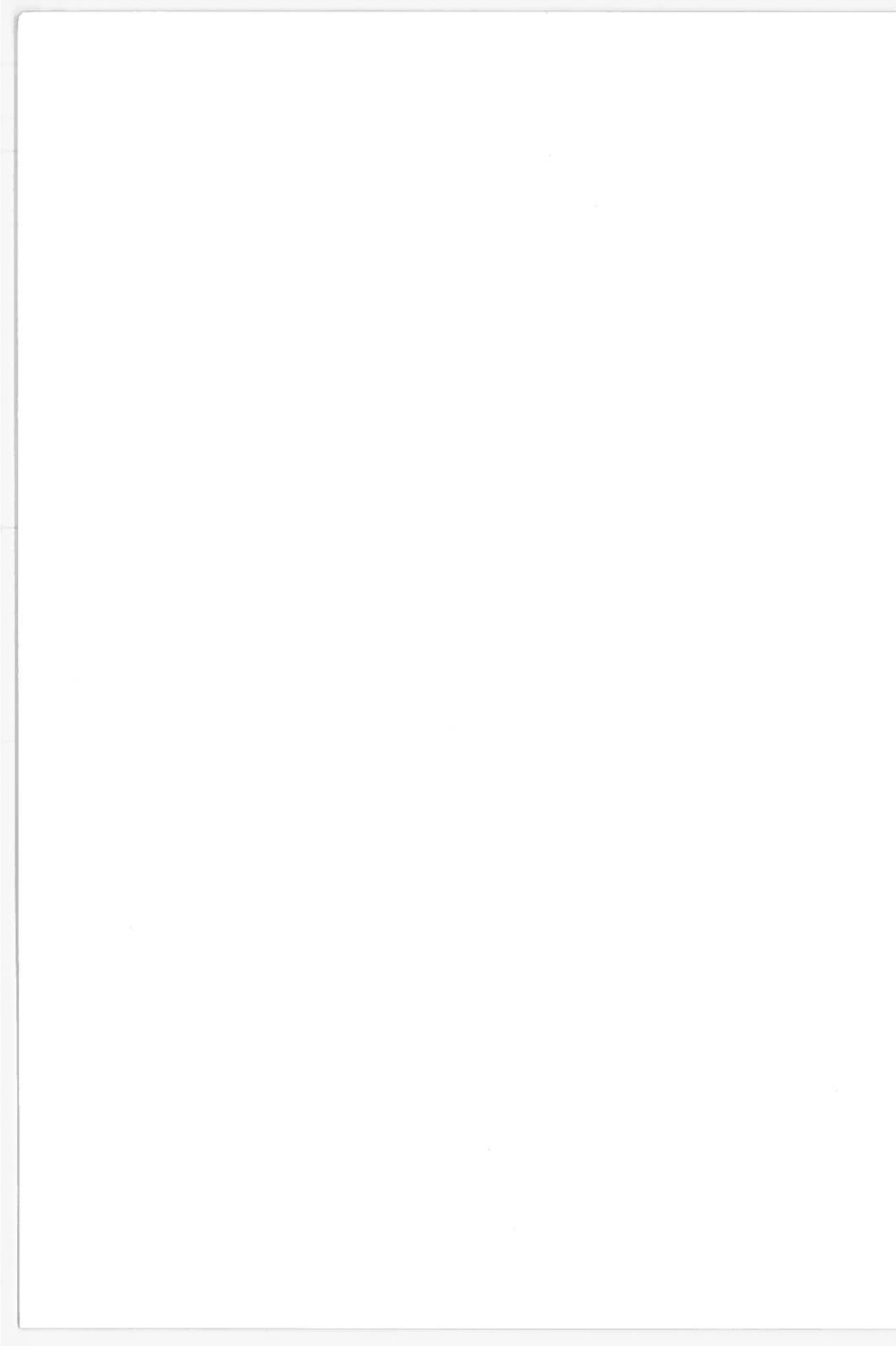
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Technical Report Documentation Page

1. Report No. DOT-TSC-OST-76-12.III		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle SYSTEMS MODELS FOR TRANSPORTATION PROBLEMS Volume III: A Computable Command-Control System for a Social System				5. Report Date March 1976	
				6. Performing Organization Code	
7. Author(s) A.S. Iberall and S.Z. Cardon				8. Performing Organization Report No. DOT-TSC-OST-76-12.III	
9. Performing Organization Name and Address General Technical Services, Inc. 8794 West Chester Pike Upper Darby PA 19082				10. Work Unit No. (TRAIS) OS543/R6503	
				11. Contract or Grant No. DOT-TSC-946	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Transportation Systems Center Office of Systems Research and Analysis Washington DC 02412				13. Type of Report and Period Covered Final Report July - August 1975	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract  <p>In this report, the spectral characteristics of the urban center - at the level of the family, the functional organized units of society, and the essential compartment balances of the urban center - are spelled out in greater detail. These compartments are food, materials, energetics, manpower, productive function, economic balance, and technology governing the system. Ideal 'Carnot cycle' efficiencies are characterized for the basic cyclic processes in each compartment.</p> <p>This is Volume III of four volumes.</p> <p>Volume I, 84 pp. Volume II, 46 pp. Volume IV, 132 pp.</p>					
17. Key Words Regulation and Control, Modeling, Compartment Analysis, Systems, Systems Science, Systems Models, Social Dynamics, Thermodynamics, Urban Dynamics, Transportation Modeling, Statistical Mechanics, Transportation Systems				18. Distribution Statement  DOCUMENT IS AVAILABLE TO THE PUBLIC THROUGH THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VIRGINIA 22161	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 90	22. Price



## Preface

In an earlier part I of this final report, a thermodynamic foundation was proposed, in a generalized fashion, for social systems. Its implications for large scale national transportation planning for the future were explored. In an earlier part II, the implications of this kind of modelling were explored for urban centers, and a generalized regulation and control model for the urban centers was developed. This control scheme applied to both operational performance (e.g., daily) as well as long term planning and policy.

In this third part of a final report, the regulation and control scheme for an urban area is developed in greater detail. It illustrates how the balance in all transports in an urban social system are to be achieved.

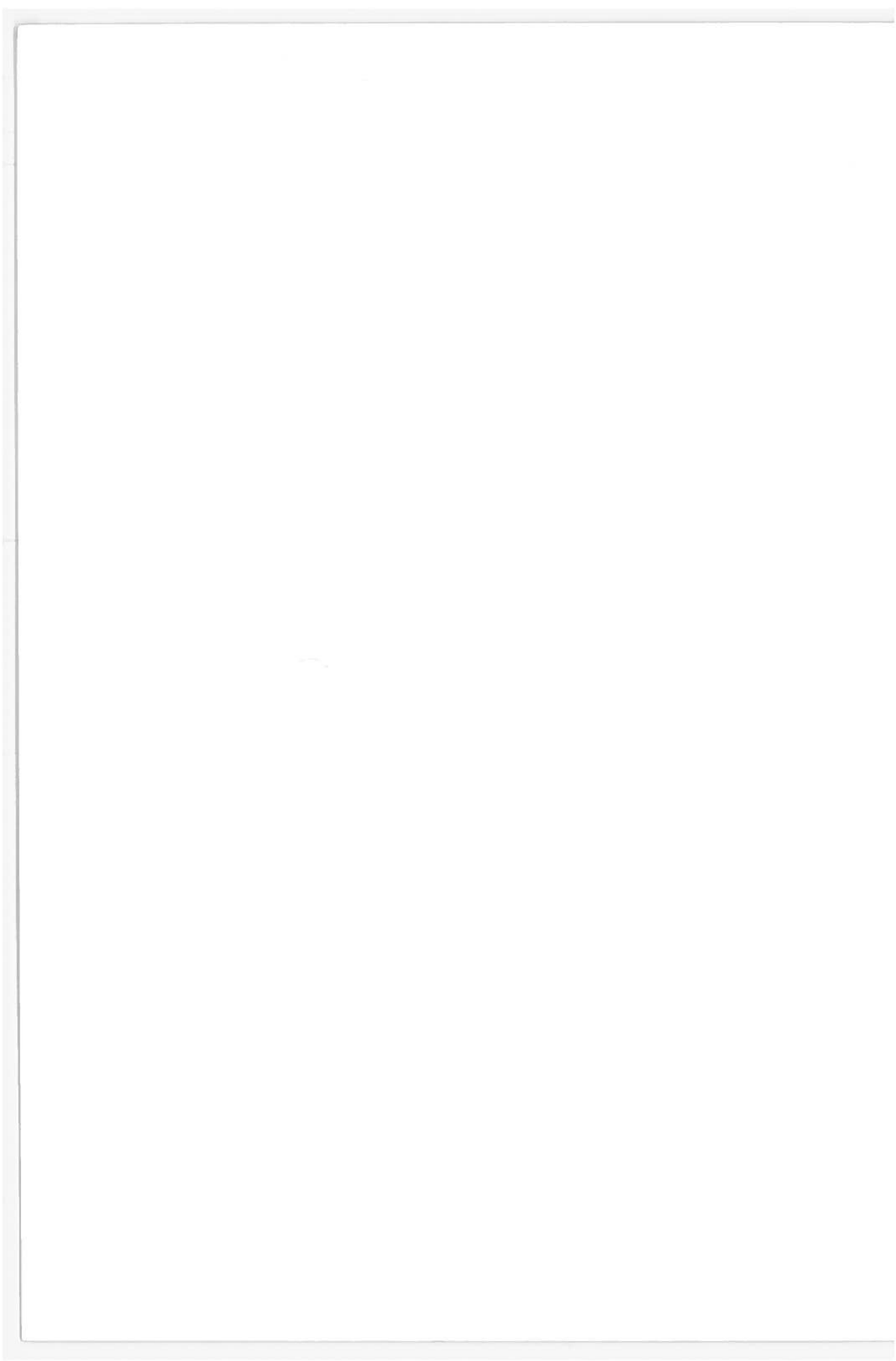
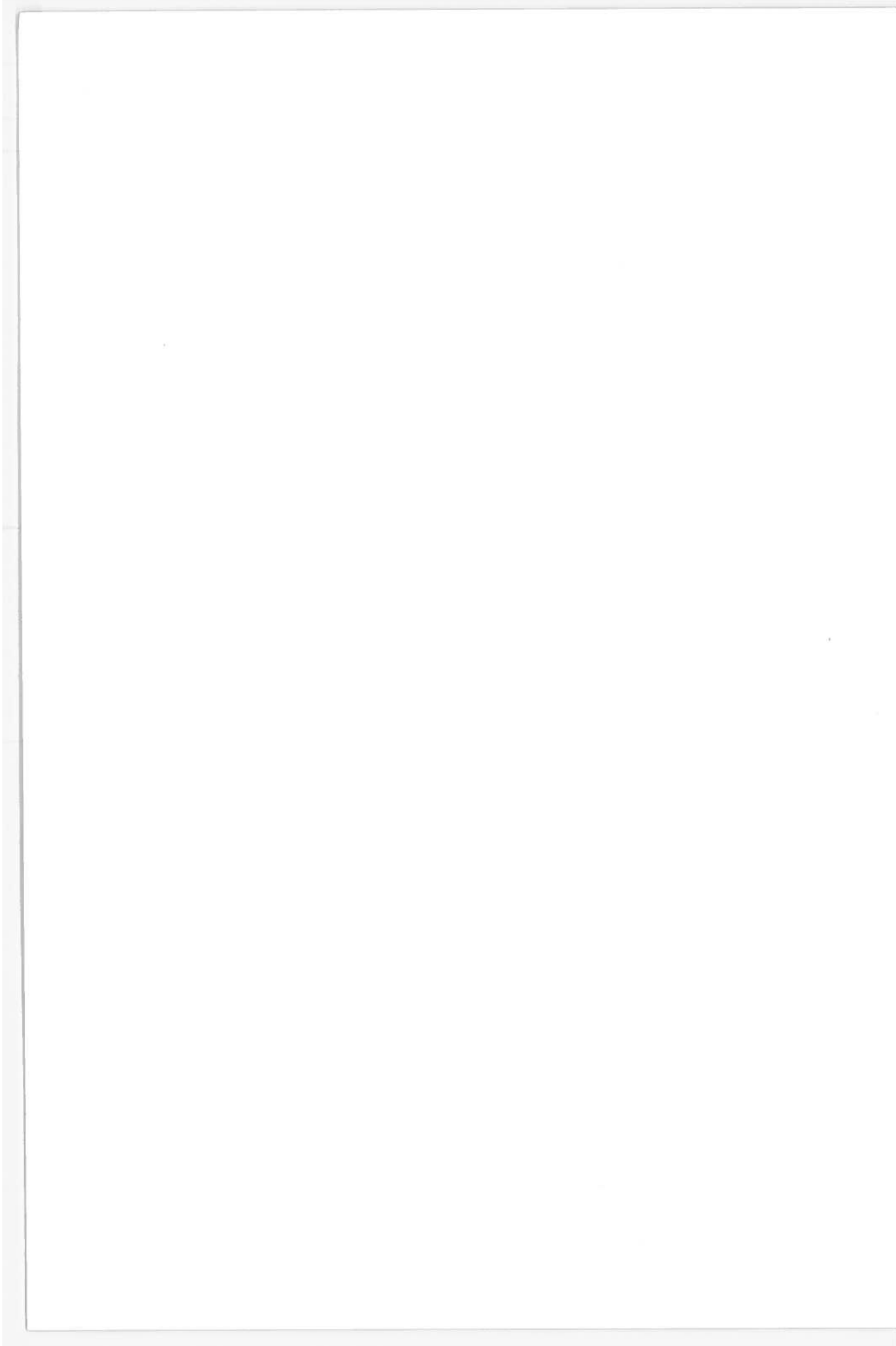


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## Level One - Atomistic Base (Monitoring the Base)

We start at the level of a Stokes-Einstein diffusion step.

So step one. Every so often (e.g., 5 year intervals), a simple data study is made on the relatively homogeneous segments of the urban area to determine the time preferred diffusion paths used to achieve the atomistic modes of the life style (e.g., both what is and what would be preferred). Note that gradient fields and diffusion coefficients are going to be derived from these data. This is required both for weekday programs and for weekend programs.<sup>1</sup>

Analyze these data and arrive at a field tensor characterization of their occupancy of the phase space of the basic human modalities.<sup>2</sup>

One, note that we are offering a people oriented, rather than a property oriented model of the urban settlement. This is because the system operation is not possible without people.

Two, the urban 'balance' can not be performed in anything less than autonomous variables. Thus the entire panoply of essential action modalities must be encompassed.

Three - but ensemble physics requires that we only deal with the summational invariants as essential autonomous variables. All others are extraneous.

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<sup>1</sup> While engaged in the preparation of this report we were furnished with some of the literature in urban and transportation planning by TSC personnel - in particular material by Lowrie and Harris (e.g., material from the Journal of the Institute of American Planners). Clearly we would have empathy for the kind of understanding that Lowrie has of modelling issues, and we are impressed by their facility in having a large computer programming capability. Nevertheless - and it agrees with both our perception and TSC personnel perception - we are duty-bound to emphasize the differences in our modelling views. We will try to stress those differences, when it seems desirable. We are not engaged in any parochial defense of 'our' views, but in a basic formulation of what a scientific theory is. That is what is missing in the literature alluded to, and which we suspect Lowrie clearly understands. Our effort is devoted to providing a basis for the scientific theory. We are certain that if we could get its rudiments across to the class of professional planners we need to ultimately influence, the task would go quite quickly. They already have much of the tools and methodology needed for reductionism. Our problem is to communicate, develop, and share ideas with them at a speedy enough rate.

<sup>2</sup> The usual urban planning is involved with such parameters as land usage and trip lengths. Since we are providing a general social physics, while we realize living species are bound by earth, by sun, geochemical constituents, and water, the binding is not necessarily to the land ownership of a particular form of capitalism. Yet, since agriculture and value-in-trade, there is precipitation in place. Thus our language tends to be somewhat more general than just for any American city. What is basic - thermodynamically - is a distribution function in which human modalities are satisfied.

Four, the implications of that notion is that it is a higher energetic, higher global profile system to attempt to 'hard wire' (guide) or 'hard gear' (kinematically constrain)<sup>1</sup> the system.

An extensive note is necessary on hard wired, hard geared systems, as compared to naturally forming inhomogeneous field systems.

A natural forming system will take its inhomogeneous 'bent' in accordance with thermodynamic law. Constraints that fit those inhomogeneities likely are lowest energetic profile.

To provide hard geared guidance that doesn't fit those constraints, or that provides over-constraints, induces the fracturing out from the system of additional degrees of freedom, forcing additional couplings and additional energetics. Can such new fracturings reduce the required energetics? Any full answer to that question is too speculative. Likely only if it can transform a turbulent field back into a laminar field. But that often boils down only to a new quantization of the field, rather than a hard geared field. More generally, the constraint requires more energy.

This note then gives us a clue on how to run a system. If the action modes in a system are essential fragments of the total action-momentum equation, then they must be caught up in chains, essentially as sub-summational invariants. They must happen in some sort of cycle. Thus why not find the periodic cycle or periodic spectrum which permits their scheduling to come off 'naturally', namely in a self-regulatory way?

Thus a governing elite can assign deus ex machina, persons or things, to provide a natural overseeing guidance for each of these action modalities. He, she, or its task is not to hard wire or hard gear the modality, but to act as an escapement, e.g., to direct rather than force traffic.

With this note, we may begin to comprehend the general soft system guidance for complex systems. There are loose chains that organize modal activities. There are time dependent couplings, some routine - e.g., spinal or hypothalamic in analogue, some part of central command-control - e.g., cortical, reticular core in analogue. This is a far cry from 'gravity' models, or better put 'potential field' models. (A potential is a parameter derived from a field whose forces just depend on distance). It is much more like a quantum mechanical exchange field.

Thus there is a loose governance of an eating mode, a voiding mode,

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<sup>1</sup>The notion of 'hard wire' has become available in engineering, for example, to indicate brain pathways that emerge 'hard wired' on birth, rather than epigenetically changeable. The notion of holonomically hard geared is a parallel we have coined. It denotes restrictive couplings, e.g., 'Thou shalt' and 'thou shalt not', forced on a system, such as society. To maintain those, if not naturally cyclic invariant, is quite costly. We wish to offer it as a basic theme in governing systems.

a motor action mode, etc., universal human action modes. What differs from one epoch to another, one ecology to another, is the difference in technology, the difference in extensions - external and internal - used to make the modes come off.

Let us proceed then to a statement of what an ideal elite command-control governance of a system would be like. In an ideal governance, the command-control leadership would assure an equitable distribution of materials, energies, fluxes, and storages throughout each of the essential compartments of the system. They would assure elites sufficient goal and reward to excite and soft gear channel their activities. They would foster a recognition of common goals and paths both for the populace and the elites. They would encourage value-in-trade and real energies and materials to stay hand in hand for stability. They would encourage a sharing - when times are good, all benefit in equal measure; when times are bad, all sacrifice in equal measure. They would recognize the fantastic potential drives toward elitism from unbalances and would thus provide an active soft self-regulation of inbreeding (of elites) and outbreeding, a process that we have described as stirring the pot gently. Bring in the young, let out the old. Reassign the old, to more broadly oriented social services. This requires a firm high and low frequency regulation and control. They would not only balance their system internally, but also externally, both with regard to 'friends' (like us) and 'enemies' (not like us).

The purpose of this description is not to provide a Pollyanish picture of a society, but a real image ideal of a society. There are classes, war and peace alternate, systems live and die, etc., but the attempt is made to run the system at its lowest thermodynamic cost.

That also includes the training, and the natural selection process for elites. A major purpose of the leadership is to discourage the hyperkinetics that becomes involved in the search for the glory of X, whatever X is. Present and future generations have to be soft guided to such notions as service to society.

Is this communism in general, or Soviet communism in particular? By no means. We have come to the technical conclusion that it doesn't matter what 'economic' system you select. Oh yes, per Marx, it is desirable that it be fashioned with an eye toward the available technology. But the basic design has to be people oriented. It cannot be slave and master, serf and lord, domesticated 'animal' and master, wage slave and capitalist, worker and party elite, etc. It requires a soft geared constraint wherein both - populace and elite - are linked into a common life purpose.

Do such systems operate without crises, without evolution? Absolutely not. But they represent the potential for the greatest degree of rationality that man can show. We encode our proposed control system with this image ideal system in mind.

Whenever you drive a system without respect to its normal modes, you get unpleasant beats, 'woofs' and 'wows' and shocks (particularly

in a nonlinear system) which tend to be damaging. The socially insensitive 'robber baron' finally provokes an organized labor response wherein, in time, big capital is faced each year by big labor. Or a party elite, who pays no attention to total human action modalities (e.g., a freedom for motion) begins to pay with dissenters and dissent, which can only grow in time to become a counterforce. And so forth.

So a moderate accommodation, in which the wings are involved (those who are proponents of change, and those who are for the status quo) significantly in society, in which the process does not sink to a mindless everlasting repetition, in which some color and pattern and diversity in style exists, in which change exists, in which all have a conscious stake in its survival, in which mobility, up-down-sideways, exists; that system has the longest chance for survival. And where the driving style can change from system epoch to system epoch, and where its *idée fixes*, those that can become destructive, are discharged at reasonable intervals. Does this guarantee against paranoia? No, but it minimizes the risk. And that, each of us who make any claim to any rationality, knows is the daily problem of existence. We have internal apparatuses - memory, cognition, emotions, language - that easily become confused and tie up internal energetics, (in the style of Freud). Our problem is not to be guided by them in too hard geared a way.

What is a tensor characterization of the human modalities in an action phase-space? First what are human modalities? The individual ones are cycles involving

sleep (and wake)  
motor act (and cease)  
externally attend (and otherwise direct)  
ingest (and cease)  
talk (and otherwise attend)  
sex (and cease)  
cogitate (and otherwise pursue)  
become anxious (and be otherwise occupied)  
store into memory (and be otherwise occupied)  
void (and cease)  
fear (and cease)  
aggress (and cease)  
envy (and accept)  
greed (and accept)  
laugh (and be otherwise occupied)  
become euphoric (and change)  
be in reverie (and out)

We can start off a discussion by asking, "Can you imagine a governing elite structure which has ministers for each of these modalities?" What is their function? To attend and gather information about the human state in their political subdivision, aimed at providing remedial measures to keep the cyclic performance in their modal compartment 'normal' and 'socialized', all conducted not by hard geared activities, but soft geared escapement activities conducted by well trained professionals.

The thought may very well be shocking.

Yet consider the notion of a political statement on the objective of full employment prior to 1946<sup>1</sup>, of child labor regulation, of concern with health, or of education, of a statement about human welfare and the "pursuit of happiness". All of these 'humane' concerns were at one time or another absolutely shocking concepts.

What we are proposing seems to be the only valid simple physical strategy, insert escapement functions through the entrance point of the fundamental human modalities.

What does this mean in action? It means that a 'minister' reports once each period (week, month, year, 5 year?) on the human state in the subdivision (e.g., "People are exhibiting 1.30% of their time in aggression; we have brought this around from 1.25% in the past 6 months. The needs are to raise the aggression levels in social groups A, B, S, and T, but to reduce them in Y and Z. We expect to take action through (a) the churches, (b) through family organizations, (c) the news media, (d) the police, by the following action programs." etc.) The elite then may suggest or approve action programs by a number of offices to regulate the social intercourse. Much of their role may be as ambudsmen.

Is this an over-controlled society image? No, for the following reasons. (It's not wrong that you're getting mad, but your're getting mad too often. We'll make changes that will result in your getting mad less often.)<sup>2</sup> Each higher degree of integration of a system places more burden on regularizing its lower level action modal chains. Thus a liver cell has to pattern its activities to conform to liver function. The complexity of a rational system requires this. But the individual does not feel overconstrained. He is constrained by the normal modalities of the system and the 'choice' he has made to be part of the system.

"Ah, but what of the right of dissent, etc.?" will be asked. But that's what we are talking about. All of such rights have to be recognized as part of the normal action modes. What we are saying is that you cannot violate the large scale thermodynamic constraints - buildings or people that defy gravity, unrestrained freedom to spread disease (not no freedom, we accept the right to give each other colds and some flu, but the right has to be restricted when flu becomes epidemic), etc.

Accept regulation through such 'natural' laws of action modes, or you have to do the engineering task. Send Moses up the mountain and let him bring down more tablets.

Suffice. Let the thought sit. What we are beginning to do is point up the real problems that exist in regulation of hierarchical systems. The fact is that the human is supplied by a reticular core, a central nervous system function that largely has to do with the regularization of these modalities. But how it regularizes them depends on interaction of the motor acting - sensing animal (the two compartment operating systems) with its environment and what is fed back through the cortical filter.

<sup>1</sup>We were involved, so we are quite well aware of the political resistance.

<sup>2</sup>We are not suggesting a feedback loop to control the populace, but to modify the governance.

Now in pre-Neolithic society (pre-agriculture), there was a slow common perception shared throughout the species, even with a division of labor. Change was slow enough that each nervous system could adapt to it. But post-Neolithic, with agriculture and value-in-trade, the rate that speeded up tremendously was technology. Its large scale diffusion rate might nominally be one roaming radius per generation (i.e., 20 miles per 20 years), but - with transportation and communication at modern rates - technology appears much more often than the mile per year rate implies. In a communication sense, people's nervous systems are shocked long before they can handle the new systems and assimilate them.<sup>1</sup> Most people have to drag way beyond the period in which the shock waves pass over them as leader waves before settling down to the much slower diffusive process wave.

So - what we are proposing is an intermediate system, in the external world, capable of rematching the 'acoustic' mismatch. In a social system, the notion may be 'revolutionary', too overwhelmingly complex, but in well-regulated and controlled high performance systems its logic will be comprehensible.

The role proposed is the leveler, the regularizer, a role that perhaps was performed by the religious institutions, but for which now some secular-scientific structure is required.

One may consider this requirement highly irrelevant, but it is a step on the way to reduce the total social cost of running a system. Today - in the day of industrial societies - it is almost impossible to count the total costs, in mental health, in depression, in social malperformance and malfunction, in crime, in punishment, etc., for an unbalanced society. To state that the costs are to be absorbed in 'private' simply transfers the higher costs to other pockets.

What we are saying, not a metaphor, is that it represents a much lower energetic cost to run a swing by tapping it via a soft geared escapement than to rig a complex support program that will maintain some artificial space-time schedule.

Or, expressed still another way, consider the difference in governing style of a Lindsey and a Beame - the former, commanding from on high (but with limited comprehension of the real power as his run-ins with Moses have shown), the latter, seeking detailed accommodation with every power group.

Thus, at the moment, we are trying to put forth the science of governance (e.g., how and where to put your fingers and draw a bow to play the fiddle) not the art of that science (how to play like Paganini). The difference involves no grasp of principles, but endless practise of exercises, and some integrative talent (both motor, sensory, and command-control).

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<sup>1</sup>The point should be expanded, but won't. Cases will be mentioned. The need for integration post-World War II couldn't be moved fast enough. TV constantly puts themes before people before they can 'see' them in reality. Primitive populations are now presented with such problems all over. One of the day, a potential revolution - e.g., in new themes from alfalfa and corn - of plants than can fix their own nitrogen, or that can conserve their high energy fixing carbon dioxide is 20 years in the future. But how should today's farmer react to that future potential? Many will be shocked. Some elite (future) will grasp its significance.

One must note the peculiar character of normal modes. Being diagonalized (or nearly so, our conjecture for non-linear systems), they tend to have independent causality and thereby no a priori reason for their common existence, but rather independent 'reason' for each of their existences. We hold no brief why what we have listed are independent modalities, only that they appear to us to be so. We have deriyed and gone over the notion from a neurophysiological and a neuroendocrine view.<sup>1</sup> We cannot absolutely assure our list, and they may be subject to some modification for biological reasons, but they are a first approximation to an objective physical account.<sup>2,3</sup>

So whether these themes are used exactly as stated, or modified to fit a political construct, or modified when experience shows that their Markov chains - their branching occupancy probabilities (do you sleep after sex, or eat, or talk, etc.) - can be more harmoniously integrated around fewer or slighter different central nervous system foci, how can they be used?

It is very likely, and this is only a first step conjecture, that attention to individual modalities has to be achieved only in a monitoring sense. It would have two purposes. It would report to the governing elite on the state (and rate) of mental well-being and physical well-being of the urban society.<sup>4</sup> It would report to the governing elite the character of existing parameters in the actual operating state of the urban society because of existing technology, ecology, culture, economics, and the political state.

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See for example our report, E. Bloch, S. Cardon, A. Iberall, D. Jacobowitz, K. Kornacker, L. Lipetz, M. Weinberg, J. Urquhart, F. Yates, "Introduction to a Biological Systems Science", NASA CR-1720, Feb. 1971.

At the time of developing and reexamining the concept of modes in human behavior (1962, 1967, 1970) we were concerned that they not be culture bound. One usual criticism was that east and west had different outlooks. Having been through a social physics (see our 5 Army Research Institute reports 1973-1975), we perceive no essential differences. For China, we offer, R. Grousset, The Rise & Splendour of the Chinese Empire, U. Cal. Press, 1962, as a useful introductory source. One might suppose that an elite operating mode that might frighten the westerner - it apparently frightened the Eastern intellectual - was the habit of chopping off lots of heads. A second note is how the literati (may we translate intellectual, academic) began to put forth a point of view that became alternately dominant in eastern thought, as one emperor pointed out, with no understanding of real-politic, of the need for war and conquest as well as peace. We are quite conscious of the burden placed on us. We are intellectuals. We are insisting that our religion (physics) is the only truth (which for the first time may even be true - an expression perhaps of our failure). We insist it be used for governance. We don't want to kill people, present or future. We don't want to save their souls for heaven. Yet we claim that we want to help regularize and reserve their existence, present and future. So we are caught with the task of making our construct complete, self consistent, simple, and unique if possible.

As a simplistic catch phrase, we can view behavior as emerging from how the limbic system switches around cortical perceptions and presses on the hypothalamus to influence the pituitary which govern how the adrenals lean on all local systems, and thereby govern the state of tension from which all behavioral switch states arise. The board of directorial reticular core doesn't care how the modal behavior is implemented or switched, only that all compartments are filled.

This is meant literally as serious science.

With regard to the first factor, there is no point to provide endless historical scenarios that could be used to illustrate the value of being able to monitor and take corrective action within these modes. Just one or two may serve. Propose building a low cost housing project in Long Island without a sense of what can be made to fit culturally. The people are up in arms in anger. End the Viet Nam war by importing refugees into this country. A fantastic split in outlook, pro and con has taken place.

We can provide one or two current examples, of a national character, of 'monitors' without portfolio who are informally given the monitoring task without any real enforcement power - Jean Mayer in nutrition (ingestion) and Dudley White in exercise (motor action). We mention them because (a) they regarded their missions as necessary crusades, and (b) they have had some effect on society.<sup>1</sup>

But what really is at issue is that these modal subjects are not really matters for vested interests, academic or otherwise; well intentioned, infinitely wise, or otherwise; but essential matters of concern to the state of well-being of a society.

Then of course, the well recognized tasks of social governance really also arises from these modalities.

Sleep is not just the human act of sleeping, it is also the associated technological arrangement of earth and extensions (housing, climatic control, furniture, land use) by which this act, occupying 30% of all human time, comes off satisfactorily. (And one big dormitory for all is not an optimal solution).

Motor act is not just the human act of moving muscles in different patterns. It involves transportation from region to region, work for food acquisition and other requirements, it involves the mobility required to be able to deal with the internal emotional modalities as well. (And one hard geared motional path for all, either in unison or in synchronized waves, is not an optimum solution).

Etc.

The monitored data on all of these modalities provides its tensor character. Why tensor? Because various of the modes require an extensive vector set for their specification (e.g., motor action. These components which define a trip, that define work, that define recreation, etc. form a vector set. These may be doubled by their rates of change.) The independence of each vector set makes them a tensor set. We do not specify the tensor coupling (e.g., as in the case of a tensor that exhibits certain invariant properties under spatial transformations).

At the time of writing, the senior author made a trip to take part in a dialogue with his friend, a well-known neurophysiologist, before his friend's students and colleagues on the relation of thermodynamics and a science of the brain - the command-control system of the complex

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<sup>1</sup>One author knows. He swims a mile a day because of a traceable effect chain to White. The other also knows. He is bugged an hour per day on the deleterious effects of not paying attention to these two men's messages.



biological organism. Similar to this project, and in general part of what we are more generally involved in, the ubiquity of a physical - thermodynamic - science for complex systems,<sup>1</sup> the question is how can thermodynamics be used in general and in detail for the scientific tasks of each particular level of complex organization. As part of our interactive exchange, our friend presented the latest forming views of locomotion in living systems.<sup>2</sup> In particular he pointed out that in vertebrates, contrary to belief heretofore, it is becoming clear that locomotion patterns are started in the spinal cord, not in the basal ganglia (or brain stem). We suddenly grasped, out of two days of intense exploration, a general theme that has been latent in our general theory of thermodynamic organization. Not only does the complex system continue to elaborate simple themes over and over again and utilize the principle of ontogeny recapitulates phylogeny (namely the natural developing thermodynamic system does not store complex subsystems, but programs an entire development from ground elements on up), but the working program for a system is found and embedded into every level. This is not Smith's invisible hand of the market place as a justification for laissez faire, or two centuries of "that government is best that governs least", but it is more of a realization of Chomsky's deep structures of the mind, a realization of cooperative structures.

People are not so perfectly coded for living that they can unfold their life along hard geared paths. On the other hand, they do not lack large numbers of orderly systems within themselves. The philosophic discussion of either the conservative<sup>3</sup>, in the implications of the doctrines of Hobbes, Locke, Descartes, and others or the anarchist, or the radical, it suddenly seems, are both beside the point as sole strategies for running the body - biologic or politic. There is a coding at every level. When released into its operative environment it does its thing (e.g., produces locomotion patterns). But that does not mean that the patterns are completely appropriate without a higher order system doing its 'supervisory' thing. All the time? Absolutely not. It cannot be run effectively for long as a hard geared system.

Thus - three consequences - strategies use an alternating pattern between permissive and coercive: there is a thermodynamics of systems which is not a network thermodynamics but a hierarchical<sup>4</sup> thermodynamics; all the bottom levels must be basically well regulated in their functions. That regulation develops in the original evolution of the system. But once the system builds further complexity, a considerable

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<sup>1</sup> See a statement that we concur with wholeheartedly - V. Weisskopf's views in Science 188, 721, May 16, 1975.

<sup>2</sup> May we hint that this is relevant to transportation?

<sup>3</sup> See an extreme form in a very recent book, R. Hozick, Anarchy, State, and Utopia, and its review by S. Wolin, N.Y. Times Book Review, p.31, May 11, 1975.

<sup>4</sup> We also managed to finally clarify this issue. Systems are stratified, but a hierarchical system implies more. There is a flow of information and authority up and down the system.

degree of autonomous regulation still remains at lower levels. This is how the notion that R. Ashby sought, of ultrastability, can arise. What we are now proposing, in an attempt to raise the epigenetic evolutionary level of the human species organized into complex technological societies, is to clearly indicate the need for regulatory processes at every hierarchical level in the system. Thus in our first level description, perhaps what we have dealt with are the modal process regulations not far removed from spinal levels.

#### Level Two - Molecularity Base (Monitoring the Base)

Very much in the spirit of the first level, an urban system exhibits social molecularities. But, as we indicated previously, these are more specialized and particularized than comes out of the genetic heritage of man interacting with his environment. These, first, depend upon the thermodynamic stability cast up by weather change, agriculture, and fixed settlement. In post Neolithic primitive form, they involve

- agriculturist
- trader
- raider
- scavenger
- deus ex machina
- nunter
- signifier
- gatherer
- cog-in-the-machine
- pastoralist
- artisan-manufacturer

But a modern technological society does not exhibit its molecular modalities in these primitive forms. Instead they relate to the local or regional needs of the modern society.

Should a society keep track of these molecularities, in what form, and how often?

From what we have just discussed, in interpolated form, we believe the thermodynamic answer is yes. Obviously, society does in a variety of (nonthermodynamic) forms. It licenses, encourages, actively seeks, regulates, prohibits, plans for, etc. But for a 'rational' scientific planning, we now have to propose it formally.

Two questions arise. One, what is the scale of the community? How to keep track? Clearly, in the first instance, the greater area to which daily transportation is largely confined is a basic candidate, rather than a narrower political urban division.<sup>1</sup> With an urban population of about 165 million, 30 urban centers represent 50% of that population, 200 centers represent 75% of that

<sup>1</sup>At the present, we have no desire to deal with the details of complexity that have been commonly studied, see for example D. Peterson et al., "Arrangements of U.S. Population by Urban and Rural Geometrical Clusters", Inst. Def. Anal., Arlington, Va., Sept. 1970. (Nat'l. Tech. Info. Serv., Springfield Va.). There is a recent review by R. Cassidy of J. Fischer, Vital Signs, U.S.A., that is of some interest. States and urban areas are discussed which have made some effort to develop regional planning programs

population, and 3000 centers represent 100% of that population. The intensity of planning can at least be related in some measure to those population concentrations.

Now clearly neither these archaic identifications nor a complete list of up-to-date occupational titles is what is required. Yet from a thermodynamic view, there is a clustering around these molecularity classes - of their social utility, or their social disutility, of a commonness of interest, whether it be highly cooperative or highly competitive. Your forms are determined by those you band to and those from whom you antiband away (the plus-minus nature of forces.<sup>1</sup>)

Thus, as a first evolutionary step (and it is an evolution of rational social forms that we are engaged in. Since it is evolutionary, it is not one unique step. It is a 'thermodynamic' step whose proposed energetics is not tremendously different from other possible proposed energetics), we would still visualize a clustering of attention around some such focal activities.<sup>2</sup> If at some ages, these focal activity molecularities actually ruled the urban area, now - no less - they exert powerful influence on the conducts of the area. Thus should not bureaucratic rulers have some idea of their state?

So, step two. We propose moderate bureaucratic data study in the following functional domains:

1. All activities related to the flux and storage of 'goods' that relate to photochemical process chains (agriculture, i.e., grown vegetable food), and similar activities related to natural secondary organic chains (animal husbandry, hunting - including fishing).
2. All similar activities related to natural inorganic process chains (gatherer - Note we no longer 'hunt' in the wild - except for fishing. But we have become very extensive 'gatherers' of resources).
3. All activities related to artisan and manufacture of goods.
4. All activities related to the trading of goods.
5. All activities related to those who are nonartisan workers.
6. All activities related to those who are negatively parasitic on society.

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How much energy both communists and anti-communists in our society spend on each other.

We might examine, the rule of Florence at the time of the Medici - see C. Albert, The House of Medici, Morrow, 1975 - with seven major guilds - the lawyers, wool merchants, silk merchants, cloth merchants, bankers, doctors, and related shopkeepers (apothecaries, spice, dye, and medicine merchants, and artists and craftsmen who bought colors from these merchants), dealers and fitters in animal skins. Then there were the minor guilds - butchers, tanners, bakers, cooks, masons, inkeepers, tailors, bakers, and others. And below these thousands of 'ordinary' workers. What is the logic of who is to rule? Is it largely accident?

7. All activities related to the intellectual requirements of society.
8. All activities related to the ruling of the society.
9. All activities relating to the care and training of the young, the care of the aged, the care of the sick.
10. All activities related to maintenance of social structures.
11. All activities related to necessary internal, non external goal directed, functions (e.g., religion, art, entertainment, recreation, escapes).

The existence of such compartments in government is not new. We don't absolutely guarantee our list. We suggest that the notion of near normal modes should be pursued in a Bayesian sense. Namely there is an a priori equal distribution of energetics among all of these compartments. Experience may show that some are 'more equal' than others in a particular cultural milieu. Perhaps it pays to try to move more toward what are the 'normal' modes because they will be lower energetic. But in any case, we consider operation near an energy minimum so that there isn't that much difference in choice in energetics of different branches.

But at the moment we are not planning a society. A society is given. It is an urban area. We are proposing a Ziebolz two time scale 'rational' controller for the region.

This means from molecular modal sample data (in these 11 compartments), reports are available on present and future states and rates among these modalities. They may be kinematically used at this level for policy. However they are not closed in a network sense. The total thermodynamic balance - in an economic, ecological, materials, energetics sense - has not been struck. But it furnishes some data base from which balances can be struck.

### Level Three - Urban Systems Base

Here finally emerges the 'real' computer control systems' model. Here is where, given an atomistic and molecular structure that seems bounded in both state and rate in their operational phase space, that systems operative modalities are organized into a working operative whole. What does that mean? We will proceed from a check list.

1. The foodstuffs balance. Roughly there is a needed flow on the daily level, but a basic balance at the weekly level (the technology of refrigeration has eliminated the need for near daily balance.) States and rates of the weekly level, seasonal level, and yearly level have to be programmed.

What kind of model for food flows and distributions, and storages are required, depends on how the system is operated. One community may operate anarchic, or laissez faire. Another community might seek to use its total purchasing power to influence the best flows, to nearly become locally self-sufficiency, to redistribute food so that all get a share (e.g., make food distribution a fundamental part of a welfare system), call its people's attention to what is

available for best distribution. (In some sense, weekly advertisers try to keep their potential customer aware of their goods. But in current USA, there is little reason, except for some prejudice, for a more equitable market not being established by TV. It is not necessary to go into details. Clearly many markets exist which have speedy and accurate flow of information as their aim.)

2. The others materials balance. The balance here is for all productive activities. Roughly, the major planning bit is on the year, generation, 3 generation time scale (i.e., what does business expect to do for the next year; but also what are their long range turnover plans; and beyond that what does the total turnover look like when the combination of their earlier dreams and realities - 'cast in concrete - and steel' - finally 'melt, thaw, and dissolve into a dew' and have to be completely rebuilt). But the working implementing level is seasonal, weekly, daily. Is there any reason - as with any other implementing actions - that delivery and other implementing decisions cannot be orchestrated for total social benefit?<sup>1</sup>

We are again forced to a dialectic. As we shall see, when we attempt to provide more detail for an operative planning system, the system cannot be planned and implemented by bureaucrats. It must also have the willingness of elites, and they must supervise its development by bureaucrats, and also take the people along. Our premise - see our April 1975 Army report on man-sciences - is that the current future of internationalist elites will take one direction, but that the national moieties that remain will have to do serious balance planning. That statement is not so remarkable. Such planning has already been begun, particularly in Europe, as an acceptable western world device, e.g., Sweden, France, England, USSR. We regard the problem as one of (diffusional) evolutionary development. The problem (at present state of knowledge) is no longer capitalism vs. socialism, but mixed systems. Namely, for the U.S.A., this is a mixed system in which inefficient operation of essential services are 'socialized' and efficient ones allowed a relatively free but bounded capitalistic development. If at any future time, an inefficient service has a recovery - say as a result of new technology - then it can be reopened to capitalism. One has to get off the ideological kicks, and begin to face the reality of limited resources. A middle age person has to make accommodations to living with a group. He or she is free to begin some limited new start ups ("Life begins at 40" and all that), but accommodation to reality status is needed. Else one approaches an old age senility, where total support is needed.

One can look around the world, and see what systems are working, adapt pieces from various successes, and one should pay attention to scientific explorations like this one. Please, the authors are not trying to advocate a socialist versus capitalist system. They are trying to indicate what a regulated systems analysis looks like instead of a controlled systems' analysis.

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<sup>1</sup> Many of these themes might sound overly controlled at some times, but quite normal at other times. Namely how much regulation, or autonomy of action accrued a city depended on historical development, and not per se on the particular form of the political system. Mostly we are considering the consequence of a coherent society, in which people and elite want to pull together for their common future.

As a basic aside, when the authors made the point in their 1964 N.Y. Academy of Science paper about the difference in regulation and control in systems, and pointed out the essential nature of control, we could sense that we were beginning to tread on the same themes as social issues. We had no foundation for a full discussion at that time. The most we would permit ourselves was the single sentence. "The authors allow themselves a bit of poetic fancy. With regard to the property of relaxation oscillation, in a hierarchy of systems the general type of nonlinear limit cycle behavior (from which regulation arises) continues to repeat - in the individual behavioral level, the group level, and the culture and civilization level. One might say that the mechanics and organization of external behavior mimics the internal biological behavior".

It is interesting that at this time we are simultaneously attempting to outline the dynamic structure of the brain and resulting behavior and command-control in the urban settlement and its resulting behavior. Our highly respected neurophysiological collaborator and we are in agreement that what is most notable about the brain and behavior is that it emerges as the result of homeostatic (or our dynamic version, homeokinetic) regulation at every functional level, and that this is the only low global profile schema for complex systems to operate by. It then becomes equally clear, in a scientific sense, that such regulations are the same necessary function in social systems. But what then is the problem? Is it the Marxian 'contradictions of capitalism' as a metaphysical dialectic, somehow caught up in the technological mode of production whereby the capitalist drives the worker to the margin of survival, only to be replaced by a worker's paradise in which the state withers away? No. It is a much more simply biological mundane problem. It is the 'necessity' issue by which colony organization could deal much more effectively with thermodynamic organization problems of extracting its living from nature, and then by which tightly organized multicellular organisms could do even better. But their functioning still left room, and in fact helped subsidize a life for some single celled organisms.

And among humans in society, it is now the simpler problem - that of existing population densities which are rate governed by resources. Now neither a profligate capitalism or socialism - whether internally or externally profligate - is indefinitely possible. Thus, 'necessity' requires the evolutionary emergence of whatever might have been recessive 'epigenes'. Man, we've got to think our way to new regulatory processes for a new social organism. And meanwhile we have to adapt it to our old social corpses, else we become corpses!

It is interesting to note recent statements of a Ford Motor executive, and the announcement of the Humphrey-Javits attempt to begin to introduce economic planning legislation.

As a pure technical matter, for those who might wonder what sort of 'network' modelling is appropriate for every compartment - as part of a Ziebolz model - namely how can the system be modelled in at least a first approximation, we would make the following observation. As an approximation, the urban area can be modelled as a distributed R,

L, C field in its minimal conservational variables - in which the region is represented as daily - weekly - seasonally - yearly - 3 yearly - generationally time dependent source-sinks. Since the population is not homogeneous, it has a weighting function (e.g., using concepts similar to Engels' curves). There are time delays. There is an 'active' structure to the transport property diffusions. There is nonlinear convections. Namely this equivalent network field description is used as a substitute for a limited 'gravity' or 'potential field' model. What we indicate by this is that we have no large objection to many methodological devices which systems people (e.g., operational research) have brought to systems modelling. What we have objected to is the 'scientific-logical' basis for the derivations in each instance. Thus at most, we consider this technique still 'back of the envelope' regulation within a broader thermodynamic equilibrium. Many of these remarks will become clearer when we get down to illustrating computable models for specific compartments.

3. The people balance. The regulatory balance is for short and long term activities - daily, weekly, seasonally, 1 and 3 yearly, generationally. Namely for their modal actions as well as their longest range procreative planning. Clearly this has many subdivisions - how they are transported, how they are housed, how they are fed, how they are cared for, how they are educated, how they are employed, how their byproduct effluents are removed, how they are recreated.

4. The production balance. The regulatory balance by which the useful productive activities that convert man's efforts to fluxes and materials, goods, by which the urban area survives.<sup>1</sup> This of course involves land use.

5. The living balance. The regulatory balance is for how and where people live - centered on the building, maintenance, and utilization of housing, for families, for individuals, for the special requirements (including transients). The time scale may be centered at the generation scale, but again it extends down to the daily scheduling.

6. The materials disposal balance. The living system - being born and living - always has to have a disposal system, that removes and breaks down materials for reuse. This involves organic and inorganic disposal, and the consequences of maintenance. In 'normal' times, heretofore, 'junk' is disposed of

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<sup>1</sup> At present, namely for the past generation, a movement to the suburbs has left center city with an inadequate basis for survivorship on its own. The latest headlines or editorials, e.g., "New York City must meet its own crisis", taken from the Wall Street Journal, Phila. Inquirer, p.11-A, May 15, 1975, indicate how the problem is left to the city. Its clear implication is retrench - in functions, services - balance the books. Clearly there is an extensive elite who have withdrawn themselves from the concerns of center city. That unbalanced rate can't persist. It is not a question of extrapolating the rate to where the state is zero (or bankrupt). Dynamic second derivative action will be taken. But - the point to be made at this time - the planning process could have seen the problem generation ago. It is a different matter to make use of 20 years to solve a problem than to make use of 1-2 years. Survivorship of urban areas depend strongly on the production balance.

at cut rates. In total balance systems, disposal takes on a different, more basic light.

7. The health care balance.
8. The maintenance of structures balance.
9. The machinery and vehicular balance.
10. The building of structures balance.
11. The common public works balance.
12. The transportation balance.
13. The procreative balance.
14. The education balance.
15. The water supply balance.
16. The defend and attack balance.
17. The governance balance.
18. The trading and economic balance.
19. The leisure time balance.
20. The technological advance balance.
21. The planning and information flow balance.

While negotiable as to specific details, these are twenty odd compartments for which systems modelling has to be provided for, and which have an analogue 'network' model for tactical and strategic control.

So now we must go back to these compartments and begin to sketch out the character of a more detailed computable model, i.e., how one succeeds in the first layer of "a high speed model of the...system built as an analogue (e.g., network or computer programs) which (a) is as isomorphic as we know how to make with the real system; (b) which receives sample input data from the real system in real time; (c) which computes out the future predictively in high speed model time; (d) which intermittently proposes outputs to controllers..."

It is understood that any clear logical program can be computationally represented, represented by an analogue, or represented by a human who takes the general purpose role of computer or analogue.

It is implied that there is some bureaucratic attention to keeping the atomisms and molecularities within the operative system.



Level Three - Subsystem 1. The foodstuffs balance.

The mean state balance is known<sup>1</sup>. Referring to the management of famine relief (there is little reason, except in extremely dire circumstances, that urban areas have to plan for times of famine. And if they do, precise data is even more useful then.), Jean Mayer offers the following data

Daily Kcal Required:

<u>Type population</u>	<u>To prevent undernutrition</u>	<u>To maintain health</u>	<u>To permit normal life and rehabilitation</u>
Children	1500	1750	2100
Normal adults	1800	2000	2350
Heavy labor	2500	3000	3250
Normal average	1800	2000	2350

The measure of minimum to acceptable diet - 500 Kcal/day - can be put in some perspective. For a 'large' city (e.g., 10 million population), with 1/3 of its population living 'marginally', requires a dietary augmentation of  $1.5 \times 10^9$  Kcal/day or  $0.5 \times 10^{12}$  Kcal/year. We might reckon the cost of augmentable food at perhaps \$1 per 1000 Kcal. Thus the cost to raise food above the marginal level is about \$500 million per year. Note that this is a rather appreciable amount. It can neither be disregarded, nor can one make a mountain about it.

For the sake of a record, we very quickly priced a one-week - one-person food basket in an upper middle class neighborhood to find out if \$14 per week per adult was reasonable. As the following example indicates, it is.

1 week - 1 person

2 lbs. hamburger meat.....	\$ 2.00
2 chickens.....	4.00
1/2 gal. milk.....	.75
1 lettuce.....	.50
1 pkg. carrots.....	.25
2 cans pork and beans.....	.60
1 stick margarine.....	.20
1 bag apples.....	1.00
1 bag oranges.....	1.00
1 pkg. tea (iced or hot).....	.50
1 pkg. rice.....	.50
1 pkg. spaghetti.....	.40
2 loaves bread.....	1.00
1 pkg. cookies & day old cake.....	1.00
tomato sauce - Ragu.....	.50
Total	\$ 14.00

<sup>1</sup> Appropriately we can reference Science, May 9, 1975 on food.

As a rough approximation, the diet seems well balanced in all respects. In time, one must shop carefully to keep variety, taste variation, and opportunity in mind. High style eating it is not.

What it stresses is that the feeding of people is a major concern of an urban area, and there is the greatest need for its elite leadership to understand that the area must be made economically viable as one component in a thermodynamic balance. Else, as has been traditional, the people are left to fend for themselves within the scope of forces that they have no conception of.

But the calorie balance is not the total issue. There are cultural, ethnic, and class status aspects of food regulation. The estimates of existing status and rates of change, and what 'ought' to be the more optimal supply is relevant to food regulation.

Here arises the first issue of modelling. Is there an intrinsic physiological-ethological drive toward good nutrition? What has represented the drive by which man's longevity has increased from 30 years to 70 years? One ruler might say "Starve the population down to half its size", another might say "Maximize longevity", etc. Policy has gradually shifted toward concern for health, welfare, life, the free pursuit of happiness. In fact many of these notions are embedded in our constitution. It becomes a potential source for network policy to develop these exchange forces that optimize the state of health among its population. If so, then there are optimal Engels curves for the existing economic class structure. Those with rising incomes will tend to want to eat more selectively than those with lower incomes. Without a class structure this wouldn't be necessary. But, just as dogs will eat all food put before them, humans have an ordered priority of preferences, and if marginal starvation does not face them, the selectivity of food is high on their list.<sup>1</sup>

But most of the issue is a balance among food stuffs. It is not difficult, in any period of history, and in any ecology, to estimate the distribution of foodstuffs among

fruits and vegetables  
dense carbohydrates (e.g., wheat, corn, rice, millet,  
barley, potatoes)  
protein rich materials (meats, fish, fowl)  
condiments and sweets, stimulants.

and to work out near optimal diets for poor, middle, and wealthy people, and thus estimate what a supply must be.

Thus it is possible to track the required foodstuffs for a city by a number of regulatory and low level control means. One can do an economic study and estimate what would be a 'most economic supply' for the urban settlement, e.g., what comes from within the bounds, from nearby communities, from more remote

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<sup>1</sup>See A. Iberall, S. Cardon, A. Schindler, "Toward a General Science of Man-Systems, A Venture into Social Physics: Beginnings", report to U.S. Army Research Institute, May 1973, p.293, "Preferred Modes of Excitation of the Human".

communities. One begins to create the market and its flow (regardless of how the market is regulated), so as to optimize the total costs to the community. Should it buy cooperatively, should it encourage and support or finance producers, etc.? Namely after achieving some sort of optimal operating point, then a study of cost-benefits can be made to intermittently probe at greater optimizations. A point is reached of effectively equal benefit branches.

Beyond central marketing, there then arises the optimal distribution system. It is no longer possible to leave pure unregulated competition and land use. Some modest competition levels, some optimization of shopping centers, some optimization of delivery, etc. is another function.

Since food is now more nearly procured on a weekly basis, its thrusts have to be adjusted to provide an optimal supply. Should this be equi-tempered shopping, or restricted time shopping using part time personnel?

There are large numbers of regulatory functions that a department of food supply can achieve - at all scales from daily, weekly, seasonally, yearly, and generationally. It is all based on the notion that food supply is a communal need (clearly it no longer is an individual, or individual family operation), and that all must eat who are accepted into the community, and that there are acceptable social functions that individuals must perform in order that their share of food is available to them. It is no issue of let the buyer beware, but one of let the dealer understand that he is involved in a communal function.

Thus, for example, at the daily scale by TV announcement (we imply that newspapers are too slow, that in time they will be superceded, and that this is a public function that might very well be done on an urban region's own station), we can imagine food prices and availabilities being posted. We can imagine a variety of regulatory functions being tested which the department could investigate. For example, one might start from a two class notion, in class one, people buy in accordance with their depletion (this may be at a weekly scale rather than daily), their notion of availability, the advertising force with which they are addressed, and the economic advantage they see; in class two, people buy in accordance with the value they place on what they see (e.g., quality, freshness, availability out of season, their taste value).

Note that what starts here is the very 'network' descriptions we are talking about. Prior to any policy practise, and perhaps at intermittent intervals, a department should just gather data with no active policy, to make certain that they form a reasonable idea of what are the apparent 'laws' governing people's acquisition of food. Intermittently they may suspend policy or make it neutral to retest their notion of applicable law. Namely in general, given state and rate (of the family larders), what facts influence the selection of food? On top of that, then, the effect of policy to change the state and rate can be determined and used in a Ziebolz two time scale computer. We have simply suggested some forms that network descriptions might take. All that we are insisting on is that this essential action modality be recognized as part of the summational invariant of momentum exchange and 'ingestion' (namely if the system is not empowered by this 'ingestion' of momentum as a field convective process, the system stops). But the ingestion is achieved by propagative-diffusive waves which can thus be described; the purpose of theory is to identify what may be the transport and propagative coefficients.

How does one handle the very poor? There are of course many ways. One way is that people show a card which indicates their economic status. Practically everyone has a unity charge (they pay regular price). The small (and it is part of economic policy to make certain the number is small) number of underearners fall into a few categories of price subsidy, e.g., 25%, 50%, 75%. The merit of such a program is that all pay, but in proportion to what they have. It makes everyone shop with care, and it can be shaded to guarantee minimum nutrition levels.<sup>1</sup>

A related tactical policy might be to charge variable tax on foods, varying with availability and seasonality, namely to enhance the sale of certain 'good' goods, and discourage the sale of 'bad' goods. The total positive-negative program can be designed to sum to zero or to any tax level that the urban area wants.

Suppose it is said, or it is found, that moving costs up and down do not influence marketability of goods. Well then, it would seem that the entire classical economic theses of supply and demand as anything more than a childish tautology would vanish (namely that there are near fixed supply and demand curves that intersect to determine the operating point). The point is very clear. Food is an autonomous variable. In the human social system, it cannot be transformed into equivalence to any other variable. Oh yes, there are 'minimum requirements' for protein, vitamins, some trace materials beyond calories, but without food being too highly adulterated and some such minimum requirements being met, people can survive very well.

Let's illustrate with one bugaboo, the protein bugaboo. The nominal requirements are about 60 gm per day, or about 50 pounds of protein per year. The higher protein quality foods run about 10-15% protein content. Thus about 400 pounds of 'high protein quality' food is required. Western nations certainly, and many other regions too, have really achieved this by 150 pounds of 'meats' and 300 pounds of milk products per year.

Clearly the mix of meat - fish - fowl - milk products, plus some high protein source vegetable products, so that people can be guaranteed of their one pound a day of high protein quality food, and one pound a day of high calorie food, can be influenced by urban policy (particularly if coordinated by many urban areas). It should be clear why historically a local region was a 'bread basket' for an urban settlement. It should be clearer still that for urban stability, it is quite essential that an urban area create very strong ties with specific bread basket zones for mutually reinforcing bonds, coops and the like.

The issue is clearly drawn. Is the maximum benefit of the elite the social issue, or the maximum benefit of the society, of which the elite is part, the social issue? The former is a philosophy, a policy, a strategy for isolated loosely connected colonial organizations, each a near predator. The latter is the required strategy for a complex interacting nonlinear organization. This is not ideology. This is science.

Note that the very character of the bonding forces - given any particular era of technology (culture may lag, even lag its '500 years', but it is highly irrelevant. The whole purpose of a social strategy in a complex organism is to speed up the communication links till it fits the scale of organization) - is that there is a scale of optimal organization. True that modern technology

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<sup>1</sup>(see next page)

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<sup>1</sup>It may be argued that the current food stamp program has already moved a very large way toward achieving this kind of program. Then the issue arises, between advocates and critics, as to whether the system is being abused to the point where people become alarmed. See for example, K. Schlossberg, "Funny Money is Serious", New York Times Magazine Section, p. 12, Sept. 28, 1975. The tenor of the author's remarks is to discuss both pro and con issues of how the system appears to be working. On the other hand, a devastating view of the problem may be formed from "Profiles - A Welfare Mother", p. 42, The New Yorker, Sept. 29, 1975. Clearly there is a more devastating criticism of some attitudes toward welfare than simply whether some families above the subsistence threshold are receiving food stamps. Clearly no society could tolerate a diffusive growth of the attitudes expressed in that article.

So what is the problem and what is to be done? We submit that there is no near equilibrium chance of arriving at acceptable social solutions (neither 'bleeding heart' nor 'every man for himself and the devil take the hindmost') unless one understands the relationships among minimal thermodynamic variables. A welfare system that worked at an equitable burden would not be a source of complaint. But when it gets out of hand - and it is getting out of hand - it is because policy has no scientific base to comprehend how current technological practise and land use and population and nutrition and family size and resources and urban concentrations and life expectancy are tied together. We abuse one or another - capitalist, bureaucrat, welfare recipient, middle class, our external enemies - when we haven't the faintest idea how all of the component parts of the system are tied together. Hopefully we may succeed in showing how these relationships are determined. At this point, we are only discussing the nutritional requirements of a society.

(e.g., thermodynamic machines, thermodynamic refrigeration, thermodynamic chains involving materials and structures) has cast the urban center loose from its local supply, and has recently (post World War II) made agriculture big business. But urban areas are also big business. If a nation is to be nearly autonomous, then its more local moieties have to also be nearly autonomous. (We do not intend to outline an entire philosophy of 'living system' organization, but it is because we have been working on the cybernetics of organization at all levels that we make such assertions. They are part of a science for complex systems, particularly one most parsimoniously organized around thermodynamic themes.) This means provinces or states or countries, and urban settlements. If it is not locally autonomous, then (like endocrine-target pairs, e.g., pituitary-gonads, pituitary-adrenals, pituitary-thyroid) minimal pairings are required. This seems to be counter 'free market', but clearly 'free market' is an illusion. Very quickly preferred paths and instrumentalities wear in. Why? Because there is no energetic parity between the molecularities of the individual and the organized group. Thus an ideal gas ensemble does not persist. Instead 'crystallized' forms precipitate, and the motion is one of larger scale domains. Thus the urban area, as a large scale 'crystalline' moiety which has to be organized to fulfill some large scale 'marketable' form-function, has to learn to assert itself in the market place. Those cities that do not recognize this now will have to recognize it within the next generation.<sup>1</sup>

All we are doing in this section is spelling out the requirements at the most primitive level of governance of essential needs. The most economical (in a thermodynamic sense) is to do the entire regulatory job in one shot - gently feeling one's way toward the optimal regulation. The least economical is to select and hard gear all kinds of old traditional notion links. The cost of churning will be fantastic.

Clearly food supply, and function, and functional ties, internal and external, and population governance, and materials and energetics flow, the governance of happiness levels, and the modification of technology are the major processes that have to be organized and regulated. And these all relate as to how internal organization takes place and how that local organism forms ties to the outer world. An older form - with slow communication, transportation, isolation - might regard the organism to be 'free moving' in its phase space milieu, but given transportation, communication, technology, this is simply no longer true. Reorganization for viable autonomy has to take place. How? Many schemes. By dictatorship, by priesthoods, by Pied Pipers, by intuition, by emotion, by artistic design, or by parsimonious science. We can only propose, you - man - vote.

Thus to make an endless fuss about the poor is ridiculous. Feed them, but get them involved into useful basic function. Else reduce the population, or reduce (or grab) more land resource, or expand the technology. Get them into

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<sup>1</sup>The 20's saw the introduction of city manager type organization which, even if it didn't take - lacking as it did political muscle - put the mark of preliminary notions of planning on the agenda. The post-war 40's was busy with a reorganization of urban areas to a larger more complex form. The 60's clearly began to indicate the beginning of a time of troubles for cities. Their organization was wrong. Cities began losing their productivity function base. The 80's will have to begin an information-theoretical guided urban system.

the useful economic cycle! This is not a plea for the poor. It is a plea for your own survival. The poor are a stability precipitate. How you run a society controls how they form. If their existence in goodly (or badly) number is the only way you know how to run a society, then you had better develop an extensive priesthood whose task is to explain to them that they are part of some overall universal plan - and convince them - else the society comes apart. You can't give them devisive messages - one on TV and another in the market place.

It is a basic issue as to how many cogs-in-the-machine molecularities are required in a complex modern society. Perhaps the stability that has to be changed is the required distribution of such molecularities versus artisan molecularities. If this were the issue, then you must understand that technology can be selected evolutionarily in that direction. We (as technicians) have no trouble in inventing that way. Elites, just encourage us.

So starting at the day, week scale the flux and storage of foodstuff - from whence they arise, what flows, where received, where distributed, how much the flows, how much the storage, the rates of change, the integrative magnitudes, the modification of demands, overseeing quality and type - can be regulated.

The larger scale decisions are made at the seasonal scale - food after all is largely governed by the season, and then at the year scale. Man's perceptive reaction creates a 3 year scale. (Governed by his informational process and decision making).

Market planning and ties are made at the generation scale.

Thus clearly what we have very lightly limned is the character of a computable internal transform system which can take information from a world of physical inputs and transform it to modelable outputs that in fact indicate what a receiver field, the consumer of foodstuffs might be expected to do. It can present such information to the consumer via various policy options as a basis for consumer action, and then subsequent use in a feedback system for modification of transform policy. It can provide open coupling to elite governance, and coupling to the dynamics of other compartments - e.g., economic, transportation. It can be begun at any level. Namely first a few humans outlining the system and themselves furnishing the computational links. Then replacement by whatever degree of automation is desired. For an immediate first design round, this is as far as we care to go without additional guidance.

Overall what we are saying is that social man is no longer a free swimming, self supplying life form (e.g., paramecium), but part of a complex interacting organism in which life processes are supported by cooperative phenomena. In biological organisms, there is a high degree of recognition and binding among contiguous and cooperative parts. We now need comparable functional chains, as well as rudimentary roads. The parts must be functionally tied, in new formal fashions. Food supply is a most primitive function.

### Level Three - Subsystem 2. The productivity balance

But in order that a food supply should flow, there is need for a productive function in a non photosynthesizing living species. It must do work, and it must do work in accordance with the available technology. With humans, this means an extensive use of material and energetic extensions. This means work

by men, work in industries, establishments, making use of establishments, buildings, machinery, materials, energies.

Obviously there are two main thrusts behind this regulation. One, at probably the generational scale, there must be a sustained regulatory program to bring productive establishments into existence. Two, at much more rapid time scales, the operational chains of work have to come off.

But what should govern an urban area's choice or selection or thrust or gradient creation?<sup>1</sup> That must be a well defined 'purpose' or 'goal'. What does the urban settlement serve? If the function is purely artificial, it will have no long term attractive ability. The area may always be in trouble. There are many ghost cities that have served their purpose and are dead. Beyond that, it seems difficult for an urban area to serve its function more than 300-500 years. There seems to be dynamic tides that sweep over the region. One can only suspect that the drive or thrust, or dislocation forming focus - as the focus for a domain - is related to stability needs for the larger settlement.

We don't threaten urban planners with that theme, we just ask that they take the notion into consideration when they do their more limited scope planning. The purpose and what they attempt to attract will tend to govern the settlement for coherence periods of the order of three generations. Thus it is with the most knowledgeable attention to technological and economic issues that the building up of a productive base must be done. Agriculture, tourism, special local product, cheap labor, high technology product, processing, assembly, specialized service function, retirement, entertainment center, wide open town? Should workers, local area, central government, give special inducements to private investors to seed productive functions? Should small diversified sources, or mammoth remote ownership sources be attracted? Etc. Obviously such functional decisions are made by local elites. We doubt our immediate ability to influence them, but in time - with fantastic lags and dead times - these notions will get to them. So meanwhile, at least we can attempt to diffuse the ideas into the periphery of bureaucratic planning.

Then beyond the attraction and start up planning, of both states and rates, and of their rates of change (the purpose of this modelling level - namely to represent those functional relations that can change the rate of change of currently planned productive facilities) there is then the operating level.

Heretofore, automation as a mode of reducing production costs, has been pursued as one producer goal. But clearly, the urban center balance has not been taken fully into account. For an urban center to survive, it must account for those functions that will keep it alive. Please note our predictions for the future.<sup>2</sup> If large corporate entities have equal or greater bargaining power than urban centers (and such status has become evident, beginning from the 20's), which leans toward large markets, and thus finally multinational

<sup>1</sup>The theme we had suggested earlier that gradients are created in living systems by temporal processing is being developed further. See for example a very recent piece about Koshland's recent work, "Tumbling bacteria impersonate nerve cells", New Scientist 66, 303, May 8, 1975. Bacteria swim, smoothly in favorable material, and tumble in unfavorable. In space, therefore, they swim to the favorable.

<sup>2</sup>A. Iberall, S. Cardon, "To Develop an Applied Science of Man-Systems Predictions USA - 1970-2040, Final Report to US Army Res. Inst., April 1975.



corporations, it leaves the local region - which still has to deal with its own people-institution survivorship - with the problem of how it can balance its life. In some areas and 20-30 years ago, a marginal farmer could eke out a life by going to work part-time in the factory (e.g., still a process in New Hampshire, Vermont), two problems now exist. There is no farm to turn to for half a life, the supermarket being the only source of produce, and a no-people-needed factory (or perhaps only a highly specialized need for people) leaves an inadequate source to turn to for the other half of life. Thus the urban center, now possessing 75% of the population (95% of the population is now non-farm) has to become increasingly concerned with the conditions of its own survival. Now it can use gas chambers if it wants to, or banish people from their domain, or convince them to have fewer children, but deal with people it must! And therefore, again thermodynamically, it must either bring them within the productive function, or must support them on welfare.<sup>1</sup> Dynamics has shown that you simply cannot tell poor people not to have children. That technique doesn't work. Population control (if not enforced by gun or power) emerges from the entire natural thermodynamic chain. More likely, when people are quite secure socially, they can relax their needs for children. Thus beyond what was a post-war accounting in the Full Employment Act, there is a need for positive stimulation of creative production facility, and not at the federal level, but at the local near balance level. For without that, we can only slide toward the bread and circus Roman route. That message is offered to present and future potential elites who want to stay here and who want an equitable system - regardless of their ideology. The technician optimization (ideology independent) suggests a mixed system, but those who want to put other constraints on it may. We can't stop the patterns that run through their heads. The main thing is for elites (who by definition mobilize people-energy) to learn to mobilize people-energy in a common direction. And productive capability is one major such requirement, if not the major requirement. How much they get paid is irrelevant if they can satisfy constraints. And of course one of the coming constraints is limited nonrenewable resources.

Then the second, more detailed technical function, of making certain that the production process performs at reasonably lossless levels, smoothly, becomes a more detailed accounting function, similar in spirit to what was involved in regulating the food supply function. Only now, the chains and paths are manyfold more, and there is more interchangeability in people and equipment function.

The engineer has a large number of equivalence processes - e.g., to make a thing on one machine or another, to use one material or another, to use one department or another, to use one person or another. All these are cost optimization trade-off processes. They have to be evaluated at states and rates in dollar space, in materials space, in manpower space, in energy space, perhaps also in system's endurance or system's deterioration space. Some comments are needed on the latter measures.

Material systems have an 'elastic range' in which indefinite stress-strain cycles can occur without appreciable creep, set, or failure. Engineers are fam-

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<sup>1</sup> Interestingly that just at the moment of writing, the telephone company announced a layoff - partly from the recession, but also from increased equipment automation.

iliar with the concept of the endurance limit, which lies within the elastic limit. The endurance limit permits an infinite number of stress cycles. While the region between the endurance and elastic limit is still linear and nominally repeatable, a system 'fails' (takes set) with one application of the elastic limit, and a failure develops - along an S-shaped curve (stress versus log of the number of applications). This is known as the endurance curve.

But it is not only materials systems which exhibit similar properties, complex systems show such properties, living systems do too. There is a level of repeated stress that humans can operate at. There are levels beyond which they can't. Thus there is an endurance space within which systems deteriorate and have to be replaced. Also there is a space of perceived deterioration.

The notion of work, or hard work itself is not the deterioration space for humans. In fact there likely are optimal large effort spaces in which peak human performance is to be found. And in fact there are such regions which are associated with high 'pursuit of happiness' rewards. So it is not a lotus eater society we are proposing.

But we are proposing a society in which perceived meaningful patterns of productive activities are designed. People have to see that what they do is useful to them, to their families, to their social molecular organization, and to their society. But clearly, in nondeteriorated industrial-agricultural societies, the planning of the production function will have to become a major pre-occupation of urban domains. Their current tendency toward bankruptcy will have to make them face up to this function. The escape of the suburban elite provides no solution. Internationally perhaps they can escape to multinational or extra-national status, but internally elite will have to become concerned with urban survival.

A Wall Street Journal article (Phila. Inquirer, May 15, 1975, p. 11A) may disclaim concern by the financial community in how N.Y. City resolves its financial crisis, today, but you may simply put on the agenda that they will have to become seriously concerned.

The subject of New York is a good one. Its story unfolds with the writing of this report, and the end is unknown (Although both the city and the rest of the culture - the State and Federal Government will have to provide accommodation). See for example, A. Raskin, "New York's Desperation Reflects That of Its Poor", New York Times, Sec. 4-1, Sunday, May 18, 1975. Or see one more of the 'last cries against planning' articles in the Wall Street Journal of May 19, 1975 (editorial column on the theme of K. Phillips' recent book).

For the record, we are not against capitalism, but the elites are simply going to have to face the need in an un-directed rudderless complex industrial-agricultural nation for steering the ship. Such responsibility and power we do not seek, but we do take the responsibility of offering a science of regulation and control - of all sorts of sys-

tems - quite seriously. Greater N.Y.C.'s net loss of jobs is clear in BLS data.

As we develop our construct, at some point the charge will be made that the proposed regulation system is only a rehash of Forrester - Meadows - Mesarovic modelling. No. In the first place, we have been developing a thermodynamic systems model as a substitute of what we thought was vacuous 'multihierarchical' modelling, and poorly defined 'network' modelling. For this end, we have provided two kinds of relevant constructs. First, we have provided a measure of the parsimonious number of summational invariants - namely the only variables by which autonomous functions can be described. Second, we have provided kinetic measures for the underlying atomistic levels from which the transport coefficients can be assessed. Namely we have developed a set which is isomorphic with the real system. When Forrester - Meadows produce systems' constants of 160 years, this is a somewhat meaningless constant. It relates to rate governed processes which likely will have nothing to do with social dynamics. Social dynamics is related to the atomistic process scales of the 4 hour ingestion period, the circadian day, the seasonal photosynthetic response of plants and entrained animal processes, the generation time. The molecular kinetics provide related scales. Warfare - a generational process in human trading constellations - is the major kinetic signal that is seen in social processes. Thus the network dynamics have to be cast with regard to these process scales. This is all rudimentary irreversible thermodynamics.

But in fact, the real argument begins at the level of remarks contained in J. Dwer, J. Mayer article, "Beyond Economics and Nutrition: The Complex Basis of Food Policy", Science, 188, 566, May 9, 1975. The question raised is where and when can planning models be implemented, e.g., a food policy.

Note we are not talking about a poor nation, we are not against advertising, we are not against manipulation of economic factors, but we do regard the future issue as serious as war situations, etc. For we really have to deal with the issue of either being at war or in harmony with nature, our minds, and ourselves.

While out of place at this point, the next issue - of the nonequipartitioning of energy - seems to be a basic one in the discussion of the empowering of human societies with value-in-trade. We are not certain whether our discussion will be viewed as polarizing, but this is not our goal (neither is it to be middle-of-the-road). Our goal is to succeed in building a science, basically a physically founded 'chemistry' of workable social ensembles. And at the same time, our goals are 'human-

istic', namely devoted to man's sustained capability to engage in "the pursuit of happiness". Is there a thermodynamics for that?

Let us state a priori expectations which, even if not purely proved thermodynamics, would seem to show some reasonable 'metrics' that would seem to be consistent with thermodynamics.

Imagine a low level autonomously sustaining chemical reaction that seems to go on upon the earth's surface (i.e., it might be geochemical or biochemical). It has its niche, and has shown considerable survival value.

But the characterization of 'low-level' implies that its energetic turn over, e.g., 2000 Kcal per day per unit is not remarkably high. In fact, per unit mass, at 1.4 cal/gm hr., its equivalent oxidative metabolism makes it conform to all other mammalian species.<sup>1</sup>

So the only remaining issue is what sort of activity does this species (homo sapiens) have to perform in order to make out in its adaption to environment. The answer - which embeds man among other primates - is gathering, with some meat eating, extended toward a more omniverous diet<sup>2</sup> so that meat eating is a more prominent part of the diet and hunting a more prominent activity.

But now imagine that the quality (and quantity) of life can be improved, e.g., the amount and quality of food, the protection from harsh environment, the life span, the diversity and pleasure of function. What charge is man willing to pay in order to receive that increase?

Let us state the issue chemically. Can man, a biochemical species, change his own biochemical reaction rates (without evolution)? We doubt it. The reaction rate can be changed as a systems' rate, not as a local ensemble rate. And for that to happen (as systems change in rate) there must be a catalyst and convection.

What catalyst? Suppose food abundance increased. But those possibilities existed at some regions of the earth. They do not immediately attract or cause a fantastic population in-

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<sup>1</sup>A. Iberall, "Blood Flow and Oxygen Uptake in Mammals", Ann. Biomed. Eng., 1, 1, 1972.

<sup>2</sup>B. Campbell (ed.) Sexual Selection and the Descent of Man, Aldine, (Chapter 3, "Man for All Seasons").

crease. The (social) system rises a little in 'temperature' (not by increased kinetic energy of the individual, but in an increased population density which is comfortable with the richer potentials available). It is only in temperate - two-climate hot and cold - regions, with precipitation-in-place agriculture that a take off toward another style of living takes place. Value-in-trade, warfare, technology, fantastic change in growth rate of extensions, - many things, good and bad - emerge. Their range seems to be the price one pays for the more diversified energetic life.

But catalyts have to be paid for. How many catalyts, how much has to be paid for? An a priori estimate, from the amount of time the human nervous system can tolerate intense abstraction - thinking, cognition, would be that about 2-3% time could be so spent. Or conversely 2-3% of the population could so devote its time - as catalyst - for the rest of the population. And how much process gain, e.g., in turnover, might be expected?

General catalytic gains might be increases of 'conductivities' or 'diffusivities' of the order of one or two orders of magnitude.<sup>1</sup>

And as to the question as to what charge might be the 'catalytic' process, as a systems' process, put on the system, the answer, fairly reasonable, is perhaps up to half of the gain.

But surprisingly - this is likely where the American 'capitalistic' system is operating.

Namely, while it would be nice if the entire populace would increase its energetics and act responsibly as 'elites' (people-energy mobilizers) - the communist ideal - they do not and cannot. Instead 2% of the population has to mobilize the process, and they take 50% of the 'wealth'. Thus their individual takes are of the order of 25 times the rest of the populace.

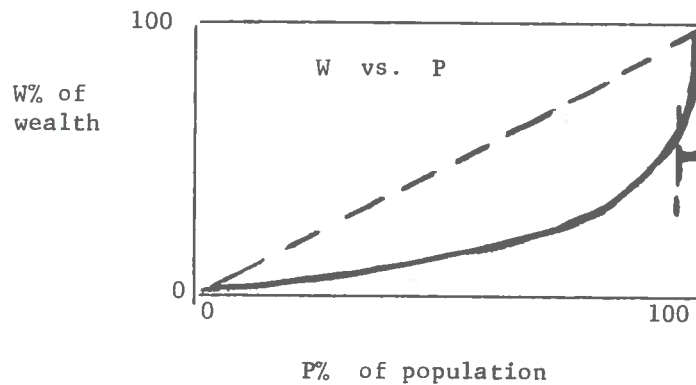
Some evidence? We have built the construct from the following numbers. (Cited in a conference broadcast by WUHY, 2-4 P.M., May 19, 1975.)

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<sup>1</sup>An example of the gain of cross channel 'eddy' diffusivity (a system property) over molecular diffusivity is A. Iberall, S. Cardon, "Aeration Mass-Transfer Related to Reynolds Number", J. Appl. Chem., (London), 16, 64, 1966.

Distribution of Wealth

Top 1/2% of population owns	25-28% of wealth
1	28-34
2	44
10	56
<hr/>	
Middle 70	39
<hr/>	
Lower 20	5



What one finds is a fairly normal distribution over the body of the populace, and a very high peaked 'normal' population for the top 2 1/2% of the population - the elite. In value - accepting a nominal total wealth of 1.5 trillion dollars in the U.S.A. - then  $0.5 \times 1.5 \times 10^{12}$  dollars /  $50 \times 10^6$  families represents an average family value of \$15,000 per populace family, and  $0.5 \times 1.5 \times 10^{12}$  dollars /  $1.25 \times 10^6$  families represents an elite family value of \$600,000 per elite family.

This is where the U.S.A. operates today, and as far as we can see, it must be near an optimal for an aggressive capitalist society.

Can we fault it? Absolutely not. Infinitely more detailed arguments might show more ideal optima, e.g., elite catalysts should only hold 25% of the gross; the lower tenth of the population should be fattened up; the elite should work harder for their take; the gross charge on the ecology should be less; but outside of such possible shifts, it is what we might expect from a usual operative thermodynamic engine.

So - man - get the point. The purpose of detailed planning is not to create communism or capitalism - but, independent of ideology, to create an operational system that has long range survival. These high energetic catalytic systems have to run with elites; elites charge; their ideology doesn't matter (whether king, emperor, mayor, president, chairman of the board, head of the ruling junta, benign or malevolent despot); if you can't do it yourself, at least see that your elite work for you (and that you can do, whether you are slave, member of a commune, kibbutz, or freeman in a self-governing' society) and earn their keep; and please don't kill all the daisies (namely respect the earth that nurtures you). Maybe you can't live at the very heap of consumption, but you can live there within a factor of less than two. Plan, conserve, think!

Why is this 'thermodynamic', and not simply jargon? We'll try to explain twice.

Once. We cannot walk up to a savage or the man-in-the-street and say build for me a chemical plant. A chemist or chemical engineer can do that. He may not know it, but he is trained in a thermodynamic paradigm. Namely he knows he has to get the mass balances right, the energetics right, the unit process steps right by which various modalities (diffusivities, propagations) come off. There is no point in saying this is jargon. The chemist has to work out missing steps, he has to make certain that what happens has a comprehensible theory for its yield at various steps in the chain. When we build a first example in the lab, a pre-pilot plant or pilot plant, it is most often a Rube Goldberg, a heterarchy of parts and components that try to guide and govern the process streams. This is not jargon. It is the use of specialized equipment to achieve well definable thermodynamic goals.

Thermodynamic again? It means focus on the essential variables necessary to get a complete physical chain together.

So example two - what might this mean for an underdeveloped nation for which we were consulting. From our limited experience, we are still far from expert. Thus our approach - subject to gaining more experience - may still be laboratory-like, academic-like.

Nominally we imagine a populace that has 'ownership' perhaps of \$200 per family (down by 2 orders of magnitude), but has survived

First, we would ask our elite employers, that they keep their cultural modalities well in mind. With those in mind - the culture having survived - we would ask whether they could put forth a goal for themselves and their people of at least a generation time to

make significant changes. We would ask that they understand that both, in their view and of the people they lead, have to accept or be led, via philosophy or values (however achieved), by the long term notion, "It's for your children!" Further, elite would have to be 'weeded out' (the ways are standard) for all those who get too attracted by short range gains for themselves - wine, women, song, castles, cars, jets, etc. A few payoffs, not too many. Hard work, driving types are needed.

We would examine how the food production yield, within the culture and taking cognizance of the more primitive 'advanced' technologies, could be increased so as to produce surplus. We would look for poor or equal neighbors with which one could develop a very strong exchange flow, of what is needed for what one has. The basic notion is to increase the velocity (or momentum) of food supply. This would require careful study of available energetics, to increase the velocity. Most natural chemical processing - e.g., fertilizer plants, some available resources - would be studied.

The selection and weeding of elites would always go on to insure that the ones that remained were coherent escapement elements, namely people who were dedicated to making the process chain come off. Their lack of sense of humor and perhaps other missing social properties have to be restored in a generation or two. Thus some future attempt at 'outbreeding' in which a more balanced view of social drives could be taken. Notice that good operational systems generally require this scaling of inbreeding and outbreeding of elites.

The object is not to sell off high value nonreproducible resources, but to use them at a very slow rate to put some meat on the bread.

What sort of political system? It really doesn't matter. It is a function of the culture, the ecology, and the opportunity to get the people moving. Namely, we are beginning to enunciate a very early form of ecological convergence.

With a well developing food supply (agriculture, animal husbandry, ocean and lake harvesting), growing up with materials, energetics, and some manufacturing surplus, tied to local regional needs, one can look forward to goals one generation in the future.

The problems - as with all social moieties of this type - is to stay out of debilitating wars or civil disorders, or subversion. The most judicious use of 'foreign' affairs manipulation is required. No small nation is master of its own destiny. So - as usual - only optimal strategies for survival can be proposed. It depends on where and when the nation is. Thus it must also have a perceived threat strategy.

And it must keep the people moving in tasks that they are willing to accept culturally.

Jargon? No. Once more it is to make use of the specialized unit



processes of the political governor. And these are thermodynamic. Materials, energies, cultural modalities, unit processes that fit are the balances that have to be in hand.

### Level Three - Subsystem 3. The materials - energetics balance.

The provisioning of an urban system with the goods that make up its food-stuffs and its productive capabilities are many fold.

The planning is again at the generation scale, modified at the operating yearly scale (the year is really dominated, in the end, by the total ecological solar energy and matching agricultural cycle), and operationally discharged at the seasonal, weekly, and daily scale. Since most of the processes are relatively routine, it is not impossible to develop and track a model of the mean productive process.

The planning of materials - energetics balances is a question of costs and availability in value space, in resource space. It has to do with working out exchange patterns with related moieties. We keep thinking of a 'free market' of world wide extent. The fact is that the market is highly constrained. The fact is that planning has to be done with one's survival in mind. And that which cannot be obtained locally had better be obtained on the basis of tight 'bartering' or 'exchange' chains. Note that this suggests a change in planning balance over the next generation or so toward a lower global profile thermodynamic balance. Design - of houses, vehicles, structures, machinery, utensils, clothing, accessories - all have to be scaled down toward more economical applicability.

Every competent engineer has an approximate idea of materials and buildings and energetics costs for structures in his domain of expertise. He is prepared, within any technological era, for cost reductions, for economies that can be achieved. He is even prepared, given some encouragement, to find means to extend life, to preserve materials, to reduce stress levels, even - in concert with scientists (a fairly rare process, although the senior author, as scientist-engineer, and as corporate research director, and as corporate consultant, has been able at various times to bridge the gap) - to develop and utilize new science to further these ends. This does not mean that a government bureaucrat can snap his fingers and a corporate bureaucracy will immediately respond. It does mean that planning goals and guides, by competent government technical administrators, can be put forth in a system - particularly in a system devoted to its survival, with a 'no escape from here' philosophy - whereby its operating state can be somewhat regulated rationally. We would suppose that some such rational planning can and does take place in Sweden.

Thus this level of planning we consider to be largely technological, economic, ecological, and with cultural limitations.

Detailed flow optimization problems we believe are largely only technical methodological issues.

### Level three - Subsystem 4. The manpower - molecular functional supply.

In order to make the productive function as a whole come off, there must be a comparable manpower balance. Again the time scales are generational,

yearly, seasonal, and daily. Also, if the national moiety operates on the basis of a perceived threat strategy function, then it is quite probable that the national moiety will call on its citizenry for some contribution to its defense function. Thus such matters have to be taken into account in urban planning.

As the themes develop in this 'next piece' report, one begins to get a sense of ancient themes. One begins to get a sense of the entire structure of feudal duties, privileges, and freedoms. One also, perhaps, gets a feel of the managed economy.

Clearly, in some historical fashion - post Adam Smith - the notion of a completely free market was developed as an image ideal of an operative system. But clearly from the very time of its conception, the past 200 years (coinciding largely with American history and practise) have indicated all sorts of 'necessary' or arbitrarily imposed restrictions on its operation. In some important sense, its history has been a relatively free diffusion and relaxation to an operational sense. Clearly large scale producer units, large scale monopolizers of significant operational capabilities or goods have received sheltered treatment. Or, as J. Galbraith has pointed out in a chapter on "Economic Security" in The Affluent Society, Mentor, 1958, "while risk was indeed inherent in the economic society of the central tradition" [of capitalism], "all those who were subject to insecurity [and risk] sooner or later set about eliminating it as it affected themselves", and "the elimination of economic insecurity was pioneered by the business firm in respect of its own operations." So capitalism's free market does not exist as a model.

Now - 200 years later - we really are faced by reforming a model of the operational market. The substance of economics - limited resources - requires it. We, as technical persons, are treading on eggs. We are offering the minimal of science, as a parsimonious - meaning also low energetic - basis for running our society. Take care of the minimal summational invariants. Don't hard gear and hard wire. Let really natural forces govern the local diffusions and propagations. Keep the high loss high social temperature processes down. Work out a minimal system of necessary relations and functions. Every tired husband is familiar with the cry, "Take out the garbage". If he doesn't like it, he has choices: Invent a new system, don't eat, beat or kill his wife or get a more tractable one. The intrinsic problem remains and physically is not transformable away.

Thus we are not designing Orwell - 1985. We are pointing out the need for person to self relations, person to person, and person to society relations. You don't like feudal relations, e.g., between you and your boss, or your customer, or your wife, or your community? Fine, propose others that are self consistent.

Clearly adult humans in complex interacting societies, except for a small number of flighty individuals, attempt to form a notion of what he or she intends to do for an extended future period, e.g., one generation, or a decade with even higher probability. In fact, social shock arises when those planned activities are disrupted (e.g., by sickness, war, layoff, or turn in economic

conditions). Thus it is hardly a surprising thing to consider one generation manpower planning.

Let us provide some measure of disparity. Suppose one asked each individual what tasks they would be willing to engage in (e.g., to provide a rank order) for the next generation. Suppose one estimated societal productive needs for that period. If the needs agreed with everyone's first choice, there would be no disparity. Assignment could follow. But suppose the disparity were great. With a long enough list of choices, there obviously would be a solution at some low enough level of choice, e.g., everyone's fifth choice, on the average, or by breaking the task into segments, e.g., quarter time segments, there could be mixed function tasks assigned to each person, e.g., 50% of 1st choice, 25% of 3rd choice, 25% of 7th choice. Thus in principle there are solutions.

But suppose such optimal solutions are not satisfactory?<sup>1</sup> What can an urban area do? It may redistribute the work load so that a large part of the populace gets higher choices of their own, and assigns the undesirable tasks to a selected minority. This is actually what happens today, by a particular kind of social planning - planning by more or less conscious exclusion.

But that carries with it a problem. What to do with those living at marginal survival levels. There are a number of kinematic possibilities. Exclude them; starve them; provide some small margin of survivorship; provide welfare. Current solutions - stemming from the private charity notions - has favored a public welfare solution. In good times, it has not been too onerous. In bad times, it begins to loom with monstrous size.<sup>2</sup>

We are not extrapolators. We are humanistic thermodynamicists. We will not give you a gloomy linear extrapolation. We point out that the generation population figures, the generational materials and energetics figure themselves indicate the growing nature of the social welfare problem. Plan to get rid of population by castration, exile, warfare, starvation, or do some social planning? Suit yourself. We don't insist on the strategy, only that one way or another you have to plan.

Given an overall generation plan for manpower, its states and rates, then the details of yearly and daily regulation become technical matters.

Then the entire matter of education falls into line (e.g., education is not only preparation for life but life itself). Education must be, first and foremost, a process of enculturation, a process in which the youthful organism and more mature organism is permitted to track epigenetically along the path that

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<sup>1</sup>The question is quite relevant at the present time. With a serious recession among deprived minorities, they are raising the question of share the work in very specific terms.

<sup>2</sup>As the flight to the suburbs took place, minorities took over American cities. Thus the A. Raskin, N. Y. Times, May 18, 1975 article indicates that in New York, out of a greater population of perhaps 10 million, there is concern with perhaps 2 million, involving 200,000 municipal workers alone, and a cost of the order of \$4 billions (i.e., of the order of \$2000 per welfare head). So 8 million have to carry a yearly burden of \$500 per person or \$2000 per family.

society and the individual require for survivorship. The rules for forcing the paths are part of the social organism's strategy. All we can do at this point is indicate that the disparity of desire and need must be dealt with socially, one way or another. You can leave the individual choose freely, and force him later, or you can optimize both.

What this means specifically, as we indicated in our discussion of consulting for a developing nation - and the U.S.A. is a developing nation, as far as what comes next with limited resource constraints - is that completely free goals always have to be modified by the social needs of the next generation. That is a network model. Warfare then makes such big changes, e.g., it may change the form of the government, that planning can only be fluctuation by fluctuation.

Those of us who have gone through the educational mill, upper class, middle class, lower class, have learned quite well what opportunity range was available to us. It is not a sharp, one channel slot, but it was limited. [And many of those who would deny this, are specifically persons who would deny us, personally, free access to many areas.]

#### Level three - Subsystem 5. The economic balance.

Given productive functions and manpower, the problem is how to make the total round value-in-trade, the money flows come out.

An introduction is useful to this theme. At this point what people need to live and what they have to do, and how to create an interchangeable surplus has been dealt with, in principle. Thus money was not particularly necessary. The system could be run thermodynamically at this level in a perfectly near equilibrium fashion (given the sun and some potential resource storage of nuclear moieties, this is an achievable balance that individual living species can reach). But money, value-in-trade, is added as another summational invariant and changes the nonlinear stability. Why? We would like to indicate a fundamental reason.

Without agriculture and precipitation in place, even given man's cultural competence, the individual was 'free' to diffuse till he fell into a viable association. Those diffusion coefficients were fairly uniform. Any specialized labor - hunter, tool maker - was needed, but an association was needed in which the skill was immediately negotiable for a common share of the common pot.

With precipitation in place and the specialization thereto, the same freedom did not exist. All of the lower rungs of effort were tied to the land. Their diffusion competence was limited. It was only a limited number of specialties that could remain diffusively mobile. They would move where it would command the highest value-in-trade. Namely their motions - longer in more favorable social solvents, shorter in less favorable - creates gradient responses. And as their value-in-trade is transformed into extensional processes, formal processes, forms form, and gradient fields are established. These then govern increased conduction - wave propagation - convection patterns. Thus these more mobile entities govern the

formation of elites and their flow patterns. Thus the thermodynamic field instabilities change.

Namely it is differential mobility of some social molecular forming individuals, nurtured by the increased kinetic transports they encourage, that transform the stability. In fashioning an economic balance, this diffusional mobility must be kept in mind.

Note, whether in a regulated market (forced) economy or a free market economy, the money flows cannot be forced - as long as the system is open - to outside transfers of goods. Thus the Russians have as much (or more) trouble with pricing as the Americans.

Thus what can planning be like in an urban settlement? Clearly no economic entity, dependent on value-in-trade by its own productivity, can afford to lose money indefinitely. There is always voting by the feet of elites. Actually there is an expectation on the growth of total wealth of any economic entity over a generation time. Its maximum growth rates are associated with size, and the general cultural outlook of the age. As an approximation, one can take the actual costs of manufacturing, renting, hiring, acquiring materials, paying for energies, and add 'profit' growths of 10% average, or 25% average peak to various productive establishments.<sup>1</sup> At the present, we have no need to develop a theory for this portion of a transport coefficient. Thus it is only necessary to provide similar or related estimates for rents and labor to have a first round base for estimating monetary flows (and rates).

Let's pursue the implication in this 'growth of wealth' assertion. It faces the same problem that we have discussed in our thermodynamic criticism of Malthusian laws of population growth, and that we found in Pareto. Endless exponential growth (or decay) violates the thermodynamics of sustained systems. Thus there must always be an accommodation of tearing down what has been built up, or building up what is dying. How does this happen socially?

We have indicated that our model is a war-to-war generation model. More reasons emerge. The war-to-war is a single fluctuation. In that scale, growth can take place. The young man, starting say with a thousand dollar surplus, if he can earn 25% a year on his money, rather than on his own labor (namely if he can directly or indirectly hire, rent, produce through technological amplifier processes a 25% yield), in a decade has increased his surplus wealth 9.5 fold. In two decades, he has a hundred thousand dollars; in three decades he is the proverbial millionaire. He has achieved elite status.

And that elementary hand-waving arithmetic contains the seeds of the basic process dynamics - not in these kinematic terms, but in terms of the individual since value-in-trade of 10,000 years, or at least 6000 years since the appearance of Ziggurats and the conspicuous urban settlements of the Sumerian age. Read the piece in our April 1975

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<sup>1</sup>A study of long term interest, e.g., how much money has earned, may be found in S. Homer, A History of Interest Rates, (2000 B.C. to the Present), Rutgers U. Press, New Brunswick, 1963.

Army report on the life style of elites in turn-of-the-era Rome.

Thus there is little reason for us to doubt our ability to build a kinetic theory of the millionaire elite (whatever the age). Basically, as we have shown, it is the control of the hundred.

So why doesn't it persist? Why not continue the Malthusian growth -  $10^6$  becomes  $10^7$ ,  $10^8$ , etc.? But that is an additional function of war. War is a jump - in the technical sense - where ownership of the scarce resources are reshuffled. Does every individual stand to gain or lose at this game of musical chairs? No. Remember that it coincides with the individual's 'reign of office', whatever endeavor he is engaged in. At most he can hand things on to whom he chooses, but the successor may not be as successful at the game. Thus, at most, as in the Medici example and the other succession examples, the most successful successions get perhaps 300 years - 10 generations rather than one.

So the wars are jumps that shake down the social trees, as fluctuation intervals. The statistical mechanics of the individual kinetic action governs the 1 to 10 fluctuations before being shook off, i.e., the inbreeding - outbreeding issue.

Does this mean that all larger and smaller configurations disappear? No, that is the point of culture. It provides the inertial carry over from generation to generation.

We regret having established one more physical reason for war (and revolution), namely to equalize the nonequipartition of the distribution of wealth, namely the symbolic title (in the mind) to the resources that exist on earth, and that man and other machines can harvest, by state and rate, and partition to run machines. Note our previous inference that revolutions are most often the concomitant of excessively onerous taxation, rather than hard conditions per se.

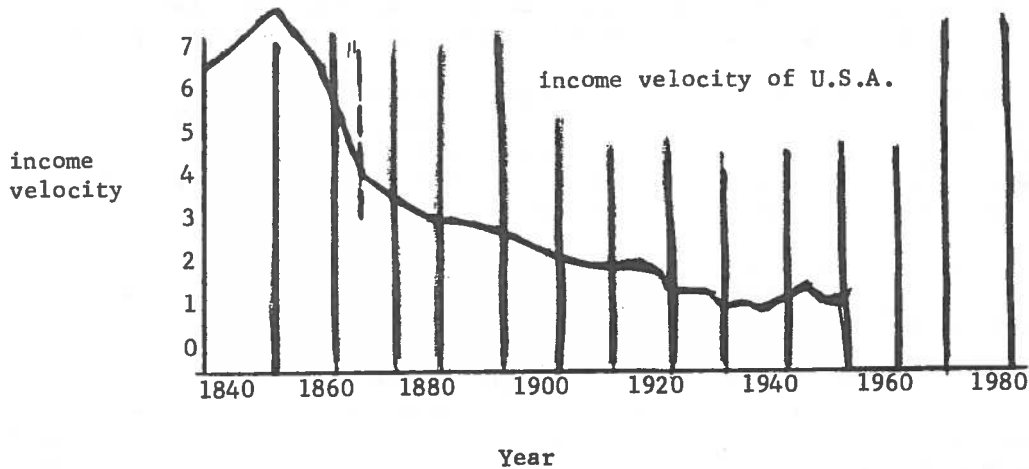
And, of recent vintage, what of billionaires that the added gain factor, technology, and a world ensemble of national moieties has permitted? You will note our prediction that they can stabilize in the future (again for 1-10 generations) by finding a disposal unit producing size, which we estimated - by today's technology - would be the  $10^7$  dollars per year producing level. In that sense, we believe that for some time this new level of elite can exist for some time among other world empires.

We may adapt one notion from the monetarists,<sup>1</sup> the income velocity. Roughly this is the yearly money income per average total money stock. (The reference, which presents monetarists in a much more charitable light than ordinarily done by other economists, offers various lengthy qualifications. The numerator, more precisely is national income and personal income less non-monetary income. The denominator is currency outside banks and all deposits, including U. S. holdings of Treasury cash and deposits in banks.)

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<sup>1</sup>We have used M. Friedman, Studies in the Quantity Theory of Money, U. Chicago, 1956.

Their most sophisticated estimate is shown below



Thus, outside of early banking start up issues (characteristic of a none fully committed value-in-trade economy) the yearly income velocity 'quickly' came down to 2 1/2 time the total money stock after the Civil War, and to under 2 in this century, to perhaps 1.3 between World War I and II, and now warbles around the 1-1.5 level depending on the state of business.

Our basic point here was not to get heavily involved - yet - in economic theory, but to show how state and rate may be brought into descriptive arguments.

It is apropos of this remark at the current time to examine A. Burns, The Frontiers of Economic Knowledge, Wiley, 1954. As his essays attack various systems (e.g., Keynes, Hicks' theory of the business cycle), one gathers the impression of a continued iconoclastic attack on potential models of a network form. For example, when he questions why an expansion of investment doesn't continue indefinitely (pp.261-265) rather than the Hicks' notion of a rigid tie of investment to output, he point out many reasons that corporate and individual investors do not carry out intentions to invest at a particular moment. The net effect is to provide an impression of a statistical mechanical ensemble of decision making atomisms that generate imperfect mechanical - namely thermodynamic - field processes. We are certain that such is not Burns' (nor Samuelson's) intent. Nevertheless, it still leaves us with the impression that our thermodynamic task of including economics within thermodynamics may be thankless, and difficult, yet still basically necessary and achievable. But, we note, as in many references we could quote, many difficulties.

With regard to land rent (or purchase), we may accept also "land rent is more the result of the market prices for the finished commodities than their cause" (Samuelson, Economics, 8th Ed., 1970).

Thus, if the total generation economic chain were carefully developed (using whatever portion of neoclassical economics one wishes), it is possible to arrive at dollar balances - state and rate - for the generation. But there

is no guarantee that the net prices that were planned for (internal and external exchange) would in fact be realized, e.g., suppose the exchange market or the world market price for major manufactured goods fall badly, or costs of necessary imported goods rose sharply. What is the purpose of the plan?

One purpose, as part of its design, is to outline that productivity function that will tend to be most stable with regard to potential unexpected shifts. For example, if no goods were imported or exported (local self-sufficiency), then there is little risk of external unbalance, except for the voting by feet of elite. That can be minimized.

But if one's urban capability is limited, then that domain of solution is not possible. One must move toward production functions where one has a greater monopoly or there is least chance for new competition.<sup>1</sup>

But, beyond the planning of such optimization strategies, there really is only one other strategy. That involves regulating the velocity of additional resource that one can put into flux, and if this is limited (in physical resource) then it is only the mental resource which can serve. Namely, beyond economic planning, there must be intellectual planning for new science - technology. It is the only last hope. (We assume that it is understood, that 'bankrupt' economy entities can either increase their scale by incorporating with other groups until a viable domain is found, or they can shed off the uneconomic pieces. But remember that one generation is a short time to make changes, e.g., in population.)

Assuming some plan and contingency plans can be arrived at, then planning - in a Ziebolz sense - becomes technical. The projections, forecasts, etc., can be presented to the relevant public, as matters of law in controlled economics, as suggested guide lines with some coercing control in more democratic societies, as a source of division in various anarchic societies. Regulations and controls - of the generation decade, political scale, yearly scale, down to daily scale are possible.

Clearly one basic coercing step is the premise that Government will act on the basis of implementing the program, so that elite advantages will accrue. On the other hand, if one comprehends elite outlook, one must be clear that such planning action will not provide them with alternate courses that cut across and subvert the plan, or else that they will not vote with their feet and not play the game. Everyone's needs have to be satisfied.

#### Level three - Subsystem 6. The technological balance.

Note that in this planning system the intellectual competence of man, locally, is the only thread that can pull the whole system into coherence - again here at the generation level. What sort of intellectual competences?

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<sup>1</sup>One simply has to examine a book like C. Cipolla (ed.), The Economic Decline of Empires, Methuen, London, 1970, to get some feel for what leads to decline of large economic moieties (or see Braudel, The Mediterranean). The time scale of decline, while perhaps a few hundred years, is often sharply localized within 1-2 generations. There is no substitute for sharp planning ahead for communities.



First and foremost - historically speaking - has been to bugger thy neighbor. (Namely, a distinction is always made between 'them' and 'us', and the process then goes on. Whether the process is better described as bugging or beggaring is a minor aesthetic detail.)

Second, if you can't conquer, accede. (That is the more peaceful remnant of the fairly general animal behavior of accepting a subordinate role.) It is only a limited fraction of the populace who can't do that. The 20th century, to cite simply the latest, has shown too many historical examples to require any extended discussion at this point.

Third, if you can't conquer or accede, then the third role is to think. And the only new paths that homo sapiens sapiens can lay out is science - technology, how new ideas might be found, how new methods, processes, chains, materials, energetics might be used to improve the reliability of the life chain.

Two decades (from the mid-50's on) of attempts to convince urban areas that they are ready for technological R & D has been fruitless - for us. Oh yes, while we didn't succeed (we started thinking about the problem in about 1953 because of a brand new friend we had made in Cleveland, Ohio. A brand new 'new generation' city planner had come to Lakewood, Ohio. As a result of interaction, we gradually began to define an R and D role for his kind of problems), but in subsequent years the beginnings of some penetration was made by 'our kind' - Rand Corporation, local universities, 'new' breed urban planning corporations. But the general need, of a deep seated science-engineering attack was out of the question. In the late 50's, having begun new hydrology science studies for the Federal Government, we tried to propose and introduce inter-actions of the urban, state, regional compact, river valley level. No success.

But the point to be made is that we did not find it possible nor believe it was possible to introduce R and D relevant to 'long range', e.g., one to three generation planning, at these political institutional levels. Now, once more on a Federal level, with a much more sophisticated understanding than we had in the late 50's, we find ourselves making similar recommendations for urban area regulation. At the time, we could only see the fantastic economic costs coming up, now we see the costs as 'thermodynamic' in every compartment.

Thus a goal directed medium and long range R and D program, proportioned to the wealth of the region, is required for its planning survival. Namely, the plan, year by year, over a generation, has to produce results in science and technology that are related to providing increased survival margin to the area.

Now there are two ways you can get new R and D results. You can either steal them (borrow and modify is the euphemism), or you can develop them yourself. (As R and D directors for companies, our general recommendations have been half and half). Also we have stressed the merit and virtue of inhouse conduct of the function.<sup>1</sup>

What is the function of the R and D program? To develop whatever is nec-

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<sup>1</sup>See for example, A. Iberall, "Advanced Technological Planning for Interdisciplinary Physical Research", report to Army Research Office, by Gen. Tech. Serv.Inc., June 1965, AD-467 051L.

essary in the form of productive capability to assure survivorship of the urban area. This might be particular farming, particular materials recovery, particular materials processing, particular new manufacture, particular aids to tourism, particular scientific research in economics, or urban systems planning, particular research in urban institutions, particular cost reduction research in housing, or building, or education, or fire fighting, or transportation, or crime prevention. It is the generation production program that has to guide the R and D program direction.

#### Level three - Subsystem 7. The governance

It is not our task to say how the urban area is governed. That is the function of the elite, with the consent of the governed (or vice versa). But that means, in such a technical oriented system that they deal mostly with matters of policy, e.g., how to use the technical flow of information, what shall be public, what shall be private. Government - as we know it - deals with the making, interpreting or adjudicating, and the enforcing of the rules of governance (as it is said, the application of man-made 'law').

We do not wish to become too philosophically involved, but a brief thermodynamic comment on the dual meaning of 'law', as we have managed to corner it now, is appropriate. In a physical-natural system, 'law' has the significance of those relations that are governed by summational invariants, e.g., the law of the rate of change of momentum in a field, of mass (due to storage and conversion), of mass species, of the production of disordered energy ('heat' flow). Living species add another 'law', the summational invariant of population and its rate of change. (Note in this context, that Darwinian evolution represents the form of the kinetic strategy by which informational macromolecules - embodied as genotypes and phenotypes - embody that law.) Man adds one more 'law', the summational invariant of value-in-trade and its rate of change. But that 'law', purely in the mind, does not deal with real countable and measurable entities. Thus one must always go back to the mind to interpret that 'law'. From the very first codes, urban at that - Ur Nammu of Ur, Hammurabi, etc. - the governance of value is on the agenda. Thus it has always been man's attempt to force a parity between man made law and natural law that has formed the basis for the newer thermodynamic governance of human societies.

With natural law, we have put forth the criterion that one must be able to go back to earth's crucible to test such laws, as to implications, consequences. Man has had various ways in which he has tried to give his law comparable strength, such as derive it from the will of God or gods, test its pragmatic, or emotional consequences, see if it doesn't violate natural law, derive it from the 'rationality' of mind, develop optimization principles such as 'maximum utility', etc. But clearly a large body is needed to enact, interpret, and enforce such laws.

This governance has and will continue to be a matter of human (elite) policy, with the consent of the governed.

Current generations of computer applications (since the 1950's) has taught

a certain number of functioning institutions how to use technical programs as a tool for policy making. We do not want to exaggerate either side. The technical side will not surplant the policy side.

An issue which we attempted to fight out in the early 50's in our automatic control circles, pointing out this fallacy in the notion of the automatic factory with multiple feedback loops. We insisted that humans had to be involved in the feedback loop. Two generations later, in artificial intelligence studies for the U. S. Army we have found no reason to change our point of view, only to deepen the content of its understanding of brain function.

The policy side cannot substitute for the technical side. History is strewn with those who try to violate that role. So basically what we require is the most knowledgeable mixed application of technique (and technology) and policy making. Some such mixing has always been the policy of rulers, so the principle is not new. That a complex society has to develop a more extended command-control algorithm is also not new. It was the purpose of automatic control theory from the mid-30's on to the mid-50's (to put an event date onto its consideration for complex process control application - Dave Boyd's attempt to develop computer control at Union Oil Products) to reach that status. (Our mentor C. E. Mason had done all the precursor automatic control applications at DuPont. We attempted some early applications with Union Carbide in the late 40's. All these events are not unique. They were new stability harbingers of the times. We have not bothered to suggest the comparable, somewhat earlier, but intertwined story of 'plant' regulation in electronic networks and in automatic pilot aircraft applications, or gunfire control applications.) By the 60's, direct digital control (DDC) applications had been achieved. As we implied, it was in the 50's that the first applications in corporate managements had been begun (examples - banking, G.E., C and O Railroad). Thus what we are suggesting, as a more complete thermodynamic regulating and control system is only novel in its total scope and the character of its algorithm, not in its underlying notion.

And, as our involvement with personnel at C and O, who were one of the first to install such an early system form, indicated, it is management who have to learn that a corporate structure requires lots of reorganization in order to take advantage of the more rapid information flow that such composite systems entail.

We may suspect that our telling of the story may not be highly influential, except to a limited few. But to those limited few, what we are saying is what is clearly on the agenda of history. The only issue is how the system will be implemented. And like all living - biological - systems, there are very many nearly alike organized systems that can succeed in carrying out the essential thermodynamic functions. Much of the issue is one of size (e.g., the difference of shrew to whale) and of the basic phylogenetic principle (e.g., photosynthetic, versus oxidative. Remember some trees live 2000-4000 years.) So we don't want to go into management (or urban area) perogatives.

## 2. The productivity account (man's extensions) - further details.

Let us return to more details about the extensional account - as we said for a nonphotosynthesizing living species. Note that precipitated-in-place

agriculture already requires technological extensions - tools. Thus all agricultural systems are industrial systems (i.e., involving 'tool' industries). The only question, at any time in man's unidirectional 'linear' technological evolution, is the level. (Again with the understanding that various areas on the earth may have lags as much as 5000 years.)

This point needs a comment. The remark is not made for its sporting character. It implies that in any one culture there may be technological aspects that themselves are 5000 years apart. Culture can be a powerful inertial force.

But even that still sounds mysterious. What it means is that process dynamics in nonlinear systems involve large nonlinear amplitude waves. Such waves, sweeping over a broad cultural epigenetic canvas, perforce plucks strings at all kinds of levels of performance. Here the cultural accretion is also fairly hierarchical. A must come before B, before C, etc. in the cultural evolutionary line. Thus one always, out of the very dynamic nonlinear mechanical-thermodynamic character of the system, finds a wide spectrum of old and new technology. Thus productivity design, via cultural understanding, has to feel carefully at what can succeed.

We face the apparent contradiction in the very recent past, e.g., from 1925 on in radio, much more intensively from 1950 on in TV, of advertising forcing of new ways, new styles, change, change, change, at highly accelerated rates. Are these notions both reconcilable? The clear answer is that the past 200 years of the explosion of machine technology, i.e., the fantastic use of extensions, and high power gain, has required a clear modification of the species' status. There was no 'natural' coding for the process, only the need for epigenetic cultural adaption. The return to elites (by virtue of increased productivity) has been enormous. It is the equivalent of any medieval nightmare of millions of busy fingers weaving cloth, making shoes, shooting guns, etc. The power amplification unstabilized the system. For how many generations? Perhaps 10. A very usual number. Why 10? Because in 10 generations the human mind skims the cream off any new intellectual notion. Might it have been 20? Yes, if the content had been much harder. But the outline of a mechanistic science - from the gross notions of systems of a Newton, the gross mechanistic notions of a Descartes, to the detailing of an atomistic structure and its applications as chemistry, as power and material mechanics, even as nuclear power - has been basically achieved in those 10-20 generations.

We who live now are beginning to see the settling down of that theme. We are caught up in its large scale waves. Many do not see these disturbances. In fact, quite on the contrary, as the point has been made, we have produced the divergence of the two cultures - of technical science and the human outlook. We go one step further and believe that there is already a three cultural split. There is the popular human outlook. There is the operational technical comprehension on how a great number of systems work at some underlying mechanistic reductionist level, there is a further avante garde vague comprehension that is intellectually developing a more complete, more highly organized

reductionism.<sup>1</sup> At present these are moving apart.

It is not difficult for us, in the third category, to foresee a coming wave (regardless of the direction that elites and economics will take), in which the development of an 'information' science of command-control, of how the brain and society as well as all of nature works - the same questions that Marx and Engels held out for the purpose of dialectic materialism, but did not succeed in embodying - will take place. Immediately? We doubt it. Again its the 1-10 generation issue, with the a priori answer lying closer to the 3-5 generation level.

But returning to our original question. The first small wave freeing the human mind, to address the question clearly (of the value of information processing), was its grasp by the elite. Class before mass. What did you want them to do with this new toy - of 'instant' communication? Obviously to use it for their own purposes, as they have every other human perception, e.g., tools, art, structures, etc. For serious purposes? No, as ever, for frivolous purposes (e.g., advertising). O.K. The 1-2-3 generations of playing has taken place. A few more such generations will be tolerated. But soon it has to become more serious. We will not point out the sophomoric point that closed circuit TV for many 'practical' applications have already begun. At the present 18 detective stories on prime TV time is the more immediate concern.

But it will pass. It will have uprooted and made whatever cultural changes it can. It has uprooted populations, made them restless, divided the generations. All true. And it is fantastically attractive. But all that will pass, and more serious applications of the medium will take place. In this next generation? Not quite. In the subsequent generation.

We pretend no great accuracy in our statements. But they represent statements related to the diffusive character of information flow in a culture, and the problem of preservation of population density. Our remarks are very small parts of the atomistic human catalyzing process of transforming information conductivity. Intellectually by our efforts, we will have added concentration changes of the order of 1 part in  $10^6$  to the store of ideas. Its catalytic capability? Who knows.

So the question facing us is what list of elements have to be planned for in a modern productivity balance. The notion is that this list could hardly have changed at any time, only the concentration of effort would change.

Power  
Housing  
Water supply  
Waste disposal

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<sup>1</sup>Perhaps to characterize it, all that which has evolved post Bertalanffy, post Korzybski. These soft trend starters nevertheless pointed the way for more significant studies.

Transportation  
Communications  
Farming  
Fishing  
Animal husbandry  
Storage  
Material 'mining'  
Food processing  
Material processing  
Manufacture  
Command-control (e.g., officers)  
Distribution  
Personnel maintenance  
Structural maintenance  
Recreation  
Research and development  
Education

Clearly all of these involve land, materials, energies, manpower, structures, allocations.

We are given (by other compartments) manpower and food supply accounts and, as we see in a feedback loop, the economic costs with which we have to arrive at some near optimization balance, how do we proceed?

The culture permits us guide rules on human living space - social class, work class, ethnic class. So we have to distribute the people through the region. (We can either design our slums, or let them form naturally. The balances are going to indicate the extent to which they form.) Many of these calculations are made by recursion rounds of estimates. The purely artificial round of using arithmetic, or geometry, or algebra for complex interrelated functions is sporting, but hardly more. The fact is that we deal with broad quite flat functions. Thus a variety of rounds of computation are useful to establish arithmetic stability of the results. First round 'computer function' estimates, compared with physical 'intuition' estimates are reasonable. Various methodologies to test global stability are also reasonable. Namely all estimate notions should 'lead to Rome', namely something that is likely a workable solution.

The basic point is that modern population density and functional density very quickly make the settlement rate limiting with regard to various supplies (There is no implication that rate limiting in urban areas was invented yesterday. Examples - perhaps 10 towns in the 10,000 population range in 2250 B.C., closer to 20 in 1300 B.C., perhaps 4 at the 30,000 level in 800 B.C., with Nineveh likely at the 100,000 level. By 150 B.C., the metropolitan areas of the large political subdivisions had populations of 150,000. This point in development is already much like 1900 USA, as far as concentrations are concerned.)

Thus if we ask what chokes a modern industrial city, there are competitors - transportation and productive income being two large ones.

So the issue quickly turns, for first round design, where do the people live, where do the people work, how do they get back and forth?

The issue is always made complex when the needs of the people and the needs of the elite are coupled. The elite always have a tendency to distort the whole development pattern of the rest of the populace. So, strategy one, is to give them their slice off the top. Design their convenience paths right away so that they can have what they want and can stay put. (To those who question this solution, the comment must be made that they don't understand that this is the lowest potential solution. All others are much more costly.) As we have indicated, that slice off the top is most often a very considerable portion of the total, but that is the price one has to pay to have an elite - whether good or bad - who will activate themselves and others.

There is nothing shocking about the notion. We already embody it in the various monumentalities that we build. It is just the engineering designer who has to get the full equalitarian dust out of his eye. Once recognized, it is conceivable that a much better design job can be done.

Now the populace can be distributed. By what algorithm? The issue is what are the production plant programs? In medieval times, one could equidistribute manufacturing function among various areas - the weavers, the silk makers, etc. We do not operate that way. We operate with efficiency of scale. But an urban area can begin to control efficiency of scale. It has been learned in the past two generations that efficiency of scale does not mean the bigger the better. In any age there is a scale which achieves optimal efficiency at relatively small size. Today, quite often, this lies in the 5 to 20 million dollar manufacturing scale. The basic issue is really the polluting industries.

Having worked on reducing pollution (e.g., substitutes for pickling of mill scale), clearly there are often process changes that can reduce pollution. But there are times and economies at which they are possible. (We attempted to sell catalytic reduction to the petrochemical and auto industry in the late 50's, early 60's, but it was too early.) So urban areas can push for, and perhaps even lead, but they cannot govern. So there really is a limit, for any generation, on how they do their production and what they can do to ameliorate its deleterious consequences. Will their producing processes kill people, stunt their growth, etc.? Certainly. All design does that. The technical person can only design with what he has available. If he doesn't design, the job is done anyway. All he gets to do is mitigate, or minimize, not eliminate.

So the placement of living and of polluting by workplace is the first design. Next to the railroad track, as is still the common design art? We doubt it. The point is that large urban areas are not designed by 'next to the railroad track' principles anymore.

Actually our long range linear railway network and meandering city design on both sides of the railway tends to be a step back toward that direction. It suggests, subject to prevailing winds and similar ecological considerations, that perhaps pollution design along the railway may be again a round for the future.

If one doesn't want 'next to the railroad track' design what then? Note one might say that a 'rational' design is to optimize over some larger area than an urban area, but we believe that solution is precluded because it begs the question.

If, by definition, the urban area is the larger area within which people are confined to work and live, then the provision for workplace can only take place by a number of solutions:

(a) there is a uniform distribution of producing centers outside of the urban area (e.g., nearly automated factories). These are precluded by stability reasons. They involve social organization way beyond in energetics any number of other solutions. Thus for example, it would be much more stable if the work centers were to cluster near the urban region as a ring. Thus they would soon be absorbed into the urban area.

(b) a central authority optimizes the placing of work places within a larger region. But this then still leaves the urban area the problem of dealing with 'its share'.

(c) the urban area has higher loyalty so that a uniform distribution of exchanges takes place through a larger region. But by definition (not as semantics, but as science), the urban area is that region in which man in dense association forms with higher stability than in uniform homogeneous association. And this has a space scale of the order of 25 miles.

So the real issue is whether newer technological transports (than human legs, or symbiotic animal performance) has transformed the scale. The answer is no. There is no 'genetic' adaption of the machine within the reproduced life cycle. Thus this genetic creature - man - still has to walk and roam his living space. Every generation, whether Sumerian villas, Roman villas, Florentine villas, USSR dachas, or American 'bedroom' suburbs, has revealed the same human drives. So the problem quickly becomes one of reconciling walking and mechanical transports.

We do not have to stress the fantastic costs that this problem has posed, in a DOT report.

Let us name a casual model for urban area formation, in more modern technological times. An attractive supply, e.g., water and raw materials, would attract settlers. Agricultural supply was premised in the larger area. Productive factories would spring up. People would live near the factories, 'in the flats'. The wealthy elites would move out to 'the hills' surrounding. Let this be a caricature if one likes (of cities like Cleveland, Pittsburgh).

Why this design? If there were no focal attractive reason, there is no reason that one urban solution has any greater stability than any other region, and thus, in the long run, they both (the real and the artificial) may remain potentially competitive as to existence.

Note, one can design formally this way, or informally. One can say, to hell with the poor. We'll design the industrial capability and they'll have to live near the factory and like it. No, they won't like it for more than 3 generations.

One way you get 3 generations is to import immigrants who will tolerate the poor living conditions for a generation. It is already more difficult to hold the second generation, and extremely difficult to hold the third. So you can say, we'll bring in new immigrants each



two generations. Fine, you can do this. Run destructive wars every few generations elsewhere and you can get a crop of new immigrants. But your problem then is to get rid of the old immigrants, who after three generations regard this as their home. You can do it by a controlled turning them into cannon fodder, or if you have 'virgin lands' to grind them down - as effective as control of remote empires - you can make them emigrate.

The point is that real design cycles are necessary as part of national empire, and we are not in the business of choosing them for you, only indicating your thermodynamically stable options. The fact is that the industrial revolution is quite recent, and it really is difficult to show maintained industrial claims for much more than three generations, without shift of the producing centers or shifts in populace.

A 'mundane' technical report to a Government department (DOT) is perhaps not the place to argue out the big and important issues about a philosophy of running and governing societies. But we either do the real job we were paid to do or we are just doing intellectual make-work quackery. The latter is not our style. Dumb we may be, but honest workmen we are!

The intellectual media are filled with debate at the time of writing about national planning - pro and against. This report makes us look like one of the most committed proplanners in existence. We would like to argue not. We are searching for the most minimal planning compatible with social stability.

The promise of the age of enlightenment<sup>1</sup> was that rationality and universal natural law could replace the irrationality of superstition, gods, and spirits as prime movers. History records that our nation was founded as a shining example that men, in Congress, could govern their own conduct. But the fact is that the rule of gods, and priests, and kings who derived their power from divine sanction (regardless of how they actually achieved power) persisted until 1920. Thus we stood on the mountain tops as an example, one of very few, that people could rule themselves by 'free' exchanges, and a 'free' market.

By the end of World War II, all nations of the world were faced for the first time, with the specific notion of rule by other than divine right. Clearly, clearly, clearly. Has this resulted in a universal diffusive drift to a democratic system, resembling ours? No, on the contrary, a most irrational acceptance of all kinds of mish mashes, mostly one kind or another of dictatorships, with rising and falling military juntas, break-up of empires, etc. We seek no pessimistic outlook. We simply report reality. Responsible rational self-government does not become the rule when man puts aside the notion of divine rule.

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<sup>1</sup>See our chapter "On the Need for a New Enlightenment", in A. Iberall, Bridges in Science - From Physics to Social Science, Gen.Tech.Serv., 1974, or Proceed. JACC, Ohio State, 1972.

And in fact we find a surprising amount of regulation away from 'freedom' in our own country, a situation which becomes exasperated when the limitation of scarce resources puts itself forth.

What can we say about the problem, scientifically? We can say, look, there is not and cannot be a free market and total social freedom. For those who want to go back, or want to conserve some institutions because of man's imperfect fallability, we can sympathize with their moral notions, but not their physics. Similarly with those who regard change as a progressive process by which man can perfect himself.

First we must explain the nominal physics of ideal solution chemistry. Ideal solution chemistry is not much different from near ideal gas physics. They are both based on a theory of fluctuations. There are deus ex machina hidden variables that support atomistic processes. Thus mean free path translational motions and relaxation processes take place. A nominal 'classical' quantized physics suggests that they exhibit cycles of summational invariance - of energy, momentum, mass. The atomistic fluctuations are related in equation of state correlation, in which momentum fluctuations are related to thermal fluctuations and volume fluctuations. There are highly subtle reasons why these correlations appear. Suffice it to say that they appear tied by near equilibrium equation of state relations.

Now the translational fluctuations have a time scale. Thus equipartitioning takes place throughout the system, based on that time scale. Atomistic diffusion and wave propagation are thus governed.

But there are delays in internal structure possible. These appear as correlated vibrational, rotational, and associational phenomena. There is the process delay associated with bulk viscosity - the spatial ability for ensemble members to locally deform. These delays are measured as those that lie outside of an energy equipartition cycle in which translational energy is converted to internal forms and back (e.g., nonclassical means). Thus one must find the bulk viscosity measure in the time delayed fluctuations longer than these cycles governed by translational time delay, in particular in the delayed fluctuations of the momentum stress tensor, or its mean measure the pressure. But the pressure fluctuation is tied to thermal fluctuations associated with kinetic energy delays, and volume fluctuations tied to associational delays.

The kinetic energy delays are largely associated with simple homogeneous atomistic bondings to form molecules with internal time delays. Thus chemistry exists consistent with thermodynamics. But we wish to call attention to the other portion. The portion associated with volume fluctuations, or 'temporary' associations in phase, is what creates form, inhomogeneous form.

At dilute concentrations, simple molecular associations can take place; one finds extensive relations all tending to be proportional to concentration, because the increases depend simply on increasing number of players.

That describes both small concentrations of salts in water solution, and man in free mobile associations around the earth. It is the conditions for freedom of choice and a free marketplace, and for the invisible hand of the market place. Then there are characteristic modes that apply to each kind of atomism. But when the momentum fluctuations are large enough to excite significant volume associational fluctuations, they precipitate as formal inhomogeneous structures. Liquids form, solids form, social institutions form. Minimally the two class society forms - the rulers and the ruled. If you wanted to stabilize the system and offer divine governance as the 'explanation', to calm fears, to provide an acceptable image abstraction, and it - an internal image - worked, fine. But the age of 'enlightenment' (to turn on a new light, as explanation) offered a different construct, a parsimonious statement of mechanistic laws of nature that man could accept. Note the two parts. The first part, of a parsimonious statement of mechanistic laws, we have achieved. If the Marxian dialectic mechanicians haven't, we have. That's what we are writing about.

But man hasn't accepted such parsimonious statements. A metaphysical 'dictatorship of the proletariat' has made as much 'progress' - since World War I or II (a generation difference) - as we have, the 'inheritors' of the enlightenment. We are not going to win by the 'force' or our moral abstract logical argument. That is not the message of the history subsequent to the age of enlightenment. And now, that we too are caught up in a nondilute solution chemistry, in where what can and will precipitate as inhomogeneous form is caught up by rate limiting boundary fluxes, are we to take the role of the Bourbons, who "never learn anything, and never forget anything"?

We do not wish to deal with the very large issues of control of the boundary fluxes, which may or may not be at our reachable thermodynamic scale. We wish simply to put 'body English' on the forms, on the regularization of the forms that must precipitate. And that is what the notion of planning in our view can be. Particularly if it deals only with regularizing the minimal inhomogeneous forms that we know will be precipitated and which will satisfy thermodynamic constraints. We are writing independent of ideology.

Thus what we are proposing is the very minimal planning system. After that you begin to have hard constraints. We are saying that the free system approaching an era of flux limitations, cannot maintain its existence.

What we are saying is that if the resource potentials are 'infinite' then you can afford a policy of dilute solution - free market. But when the field fluxes become rate governing from outside, then (a) you no longer have near ideal gas configuration - inhomogeneous forms precipitate out, and (b) you must have a policy in order to keep the macro precipitated forms in movement. Now, they are rate governed.

We are not interested in our demise, nor in a hard geared Communist system. We don't want to give them an easy victory. And we cannot run back to 'start up' everyone-has-to-work-very-hard conditions to find out who will be the next round generations of victors.

Thus we are resurrecting Aristotle-Machiavelli, a guide for rulers, a thermodynamic guide. It is the best 'middle-of-the-energetic-road' between the liberal and conservative (or radical and reactionary) extremes. How people will respond to policy, when informatively made available to them on a large go-no go, binary decision scale, remains to be seen. But remember, it's the few generation scale which determines the success, not day to day results.

On the other hand, the scale of perceived threat of war generation by generation really looms as the major rate governing process large scale. We have no way to abolish wars except by lobotomy or chemical control. So each generation must do its planning with those war induced changes in mind.

We have had many 'cosmetic' attempts at city design, e.g., R. Moses road oriented attempts in and around New York, and the many classical architectural attempts at partial or complete city design. We have no desire, at this point, to enter into serious dialectic with those professions (of structures and road designers). We want to at least indicate a few very basic principles.

As we indicated with regard to the 'design' of rivers, blood vessels, and nervous systems, their optimal design stems from the inhomogeneous formal reconciliation of conflicting requirements (e.g., to carry off water and to carry bed load). At high energy, bonds become broken and all entities spin and whirl free, in a new ideal gas configuration. At lower energy, precipitation of form takes place both to form homogeneous (sub macroscopic) 'chemical' bonds, and inhomogeneous physical configurations.

The problem we have in the city, with limited resources, is to reconcile function formally to satisfy conflicting needs. While one might say that architects have long understood that, it is far from clear that any understood the basic physical science of the process. And the purpose, now, of trying to understand the physical science is to provide a common foundation where scientist and engineer and architect and planner and elite and T.C. Mits (Gamow's playful identification of The Common Man In The Streets) can all understand the design game that has to be played out. But again, our scientific problem is the specification in the minimum number of essential variables.

Living, working, and transporting are the three functions which have to be optimized in a region. Working also breaks down into polluting - poorly tolerable - work places and acceptable places. Living also breaks down to living for the elite and living for the rest of us. Also economy of scale, for work place does not have to be exceeded. Such a specification is like a specification for a living system. Natural processes have indicated that with some materials at hand (powered cells that can be specialized, with their empowering organelles, and a simple chemistry based on organic batteries - 'cells' - on-board oxidative engines or photosynthetic engines and ion exchange), they can provide diversified solutions of complex organisms that fit the milieu. There is no unique solution for a complex organism.<sup>1</sup> Many equienergetic solutions exist. Some are more 'intelligent' than others,<sup>1</sup> but that hardly is relevant to the longevity of fittedness.

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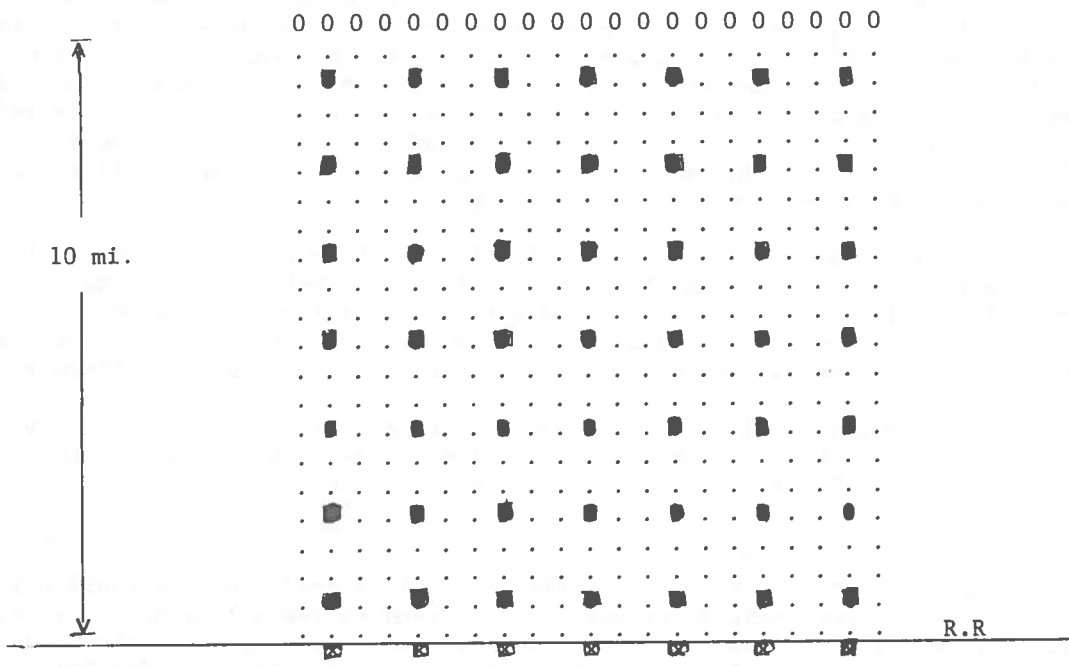
<sup>1</sup>That is the anthropomorphic judgment of the judges. In nature one can only judge by longevity of fit and the new branchings, of high longevity, that it promotes or evolves into.

If we did out thermodynamic job fully, we would at least offer a principle like the Carnot cycle, which would characterize the ideal efficiency of an urban process. Without doing this formally, we believe the notions we have suggested already imply the boundaries. We are more concerned with getting the qualitative restriction of the inhomogeneous bounds down as the design limitation.

The Carnot cycle was based on the notion of carrying an ideal homogeneous working substance - a 'fluid' - through a cycle. We recognize that an optimization based on a number of independent characteristics roughly assigns them equal weight (e.g., as by the use of Lagrangian multipliers, whereby the distribution function for atomisms is estimated). So we prefer, at the present, to simply deal intuitively with these notions rather than fully formally. (Namely there is a large degree of parallelism in what we are trying to do for inhomogeneous phases and Gibb's treatment of physical and chemical phases in chemical thermodynamics.)

So the nominal inhomogeneous assignment gives equal weight to common housing, elite housing, good work places, bad work places. There are limits of economy of scale at any particular technological era. It is understood that this is bounded at any particular era, also by a bounding size, a population, an economic burden. The object of a computation is to determine whether the actual designed layout is near the optimal design layout, and thus whether future long range change can improve the layout.

Thus, for example, the following layout is a very rudimentary example of a 'minimal' city layout.



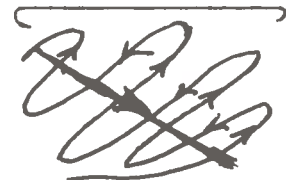
Each dot, for example, might represent the center of housing of 100 families. Each box, assuming an economy of scale of about \$20 million (in the current era) employing about 1000 people, then is a productive unit for that area. Shopping facilities, etc. are not shown. The crossed boxes represent a hypothetical collection of undesirable factories at the 'edge of town' (an edge along which a linear supply railroad can operate). Open circles (at the opposite edge of town) are a put aside region for elites (e.g., 2% of the population). Exemplary transportation systems are given in the following figures:

elite transportation



in and out spirals,  
two radials.

elite transportation



space filling curve  
one diagonal

In this 'near Carnot'<sup>1</sup> model, the local neighborhood can reach its income producing center - a 'factory' of production - by walking, bicycle, etc. This takes nominally the 1/3rd of a population (e.g., 80 million labor force out of 220 million) that is so occupied to work by foot. It can be used to break the back of the transportation problem, in an ideal sense. Then nominally 1/3rd of a population goes to school. Thus the same concentration served by factory can be served by school. (The efficiency scale is comparable, or can be adjusted.) The other 1/3rd that stay home can also be served for shopping say, by a similar concentration of shopping facilities. (Again the scale of efficiency is comparable.) This is supermarket size. As far as delivery is concerned, the scale of weekly shopping can be served by strollers (4-6 bags per week being the family requirement). In many cities, this kind of shopping pace (of a mile walk) is nearly in sight (a slight matter of bearing efficiency in the stroller would do wonders, particularly on non choked streets).

So in this ideal model, transportation is down to a space filling single in and out path for the occasional traveler. That travel path supplies the centers with goods at off hours (and alternating with passengers during the day). For the occasional passenger the transportation is frequent but somewhat 'slow', although that is relievable by the number and kind of short circuiting diagonals.

The model has a domain for the elite who can and have to be served in a fashion that suits them. For example, the likely possibility is use of the transport lines with their own, rather than a public vehicle.

<sup>1</sup>The assumption is made that by geometric-topological design of the conflicting rate-limiting thermodynamic functions, one can tend to reach a Carnot cycle kind of limitation for the essential rate limited fluxes. Although this should be achieved by some very deep topological reasoning, it is believed sufficient to suggest that one can come 'close' by actual attempts at geometric design. The point is that various computations for optima or near optima can be based on these 'good' models.

The model has pushed undesirable factory locations off to one (or more) sides. How do the people who work there get there? One of two ways, either a convenient fast transport from particular regions is provided for them (namely there are positive incentives to work there), or else the strip nearby becomes a slum and the 'poor' are driven into those areas (the usual negative incentives to work there). In any case, in one form or another, society has to 'subsidize' both extremes, the elite and the poor, and the total a priori take is about 50% for both, divided 48-2.

Let us illustrate the arithmetic:

Total families  $50 \times 10^6$     1%  $\equiv$   $.5 \times 10^6$   
 Total income  $\$1.5 \times 10^{12}$     1%  $\equiv$   $1.5 \times 10^6$

	Distribution		%
	Elite	Middle	Poor
	2	90	8
	48	50	2
Take:	\$720,000	\$17,000	\$7,500 per year per family

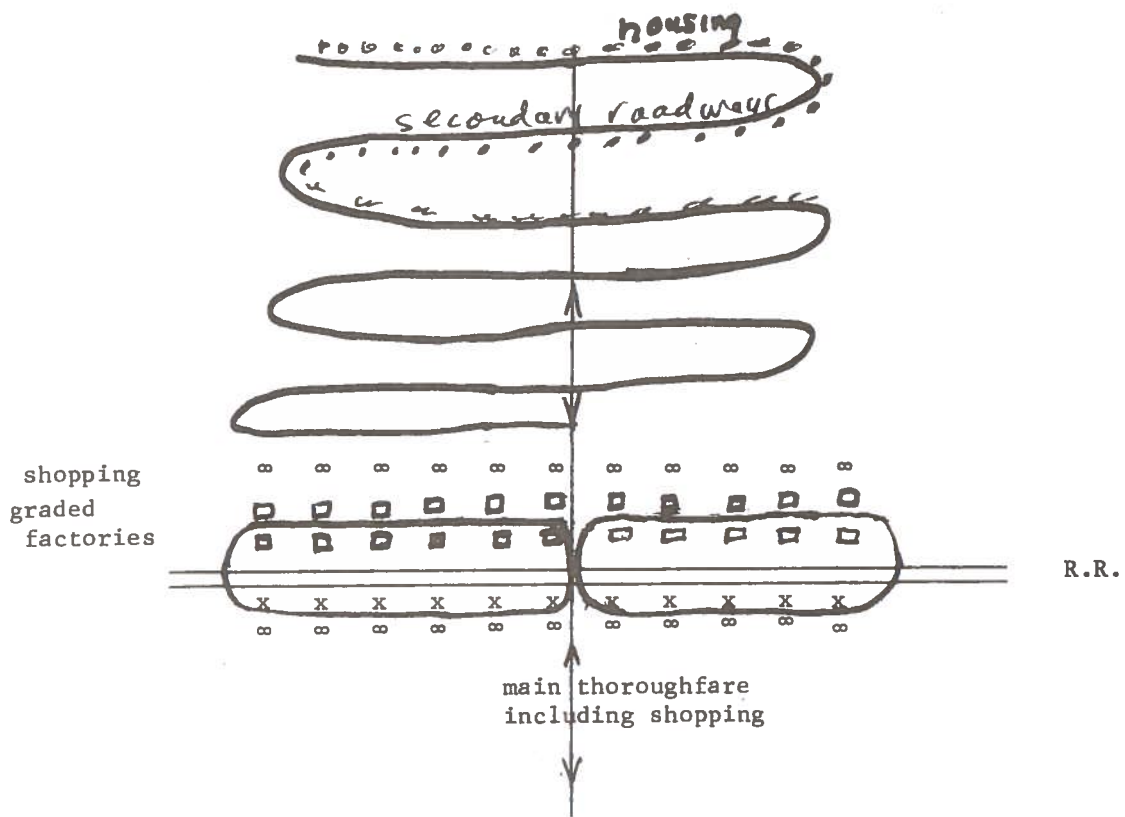
The numbers are not exact, but they illustrate the spirit of the calculation.

Now actually the factories along the railroad are not only the nominal 'undesirables', but also those that require frequent railroad sidings, i.e., a large delivery size or volume.

This kind of 'Carnot' cycle can be asked all sorts of questions to determine ideal optima, e.g., average travel path, number of paths, etc.

Again we must stress that this is not the design of an actual city. It illustrates the state of design of an idealized city that nominally performs the same functions as an actual city. It permits one to estimate the 'ideal' or 'near ideal' thermodynamic fluxes and potentials that are in accord with boundary conditions. One can then note how far removed the actual city is from the ideal, or one can then use either the ideal or the real as a basis for estimating an improved balance model. Namely what happens if you bring in more industry to change an economic balance, etc.

Another 'ideal cycle' city is represented as follows:



The railway acts as a major link with the rest of the world. Factories (and offices) are distributed along the railway. These are graded - in size and function and unsuitability to conform to topography and meteorology. A major transportation thoroughfare brings traffic in and out from living area to working area. Shopping facilities and service facilities of all sorts are distributed both along the factory area and the primary transportation line. Secondary roads meander in a space filling pattern. Not shown is an extendible reticulum of 'capillary' roads that permit the sideways (with the railway axis) or transverse (away from railway axis) expansion. That secondary system can be provided with nonpolluting transports, e.g., bicycles, chargeable electric power (chargeable at either end) or rotational power.

Note that this layout involves a lot more of the rate limiting process - transportation - than the other, and this is likely quite a bit removed from a 'Carnot ideal' efficiency.

A major point implied is that one can run a system at any level above 'Carnot cycle' efficiency one wants to. This constantly costs more of the precious flow of entropy (ordered energy) that is available at the boundaries as supply fluxes. It is this design philosophy that permits one to move away from rate governing fluxes - or in the end, suggests when 'thermal' death is near for a system.



Thus one can add all the flow of automobiles one wants, all the flow of 'conspicuous consumption' dollars, all the flow of scarce nonrenewable resources, e.g., materials, one wants, but the account balances ultimately will not pay for it. That, over and over again, is the basis of thermodynamic reasoning.

Back now to primitive issues. What did we want this kind of land planning to achieve? The issue that will exist (in an American free enterprise elite system) is that bureaucrats have no right to plan such usage. Subject to some moderate 'zoning' restrictions, any builder should be able to come in and build what he wants.

But obviously this is not the case. The urban areas of the USA present a fantastic array of builders' freedoms and restrictions. We are discussing simply their rationalization - if you will - by many possible styles. But there is one basic rationalization that is being proposed - the thermodynamic balance. Why? Because you can no longer face, with limited resources, rising welfare costs (e.g., 11 million families on welfare, February 1975, at a cost of about \$50 billion per year), rising school costs, rising transportation costs, energy shortages, material shortage, etc., and above all wrong things in the wrong place or at the wrong time.

So minimally, we are asking 'bureaucrats' or technicians or 'experts' to furnish themselves with optimal land use layouts, and to furnish any other design, that they locally feel they must 'politically' propose. At least the differences will be clear to the observer.

Or conversely, when builders walk in to planning commissions, they are confronted with some restrictions that are more 'rational'. If they have the elite power to overcome these restrictions, there is nothing that bureaucrats can do except drag their feet. But all this technical people know. So 'rational' planning, with the use of Carnot efficiencies, doesn't overcome, at most it can mitigate, standard social irrationality.

The equally serious task (equal to designing land use layout) is to properly attract the required producing facilities to the urban area. This task requires 'investment' on the part of the elite or someone. And that investment has to come from past savings, inheritance, or other risk taking. To the extent that the system can be self balanced, i.e., the investment savings comes from the urban area's own elite or from the populace (which can either be drawn capitalistically or socialistically) this is likely advantageous. One must remember that it is economics, professions, and ethnics which govern the workable urban patterns. Thus design which fits these availabilities is essential. The problem is the deficits or excesses.

When urban areas begin to have excess producing capacity, these plants or industries act as a short circuiting flux source.<sup>1</sup> When a deficit, there is a gradual rotting of the region.<sup>2</sup>

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<sup>1</sup>Witness the developing problems that Alaska faces now with building of the new oil pipe-line and oil supply.

<sup>2</sup>Conversely one can note the great difficulty that exists in Italy in trying to get sufficient industry into the south.

And as a basic 'strategy' (namely a technique that has a higher branching probability of success)<sup>1</sup>, it is likely more desirable to alternate and mix inbreeding and outbreeding. Namely bring in new investors at some finite rate.

The correlary to this is that it is not only new investment and the continuing development of new productive facility that must be brought in, but also new technology. Thus a continuing effort must exist to get R and D done appropriate to the long term future of the viability of the urban area. This is a 'new' thought. We have vaguely considered it for the past decade without being able to 'sell' it. Now we recognize it as a major strategy.

Namely, urban areas turn over in lifetime. (If they don't have size or have the serious concern that makes planning appropriate, they do not have the lifetime concern that makes the problem of survivorship compelling. A pre 'Neolithic' for-the-time-being settlement, even if its purpose was the more modern one of mining gold or oil or what-you-will, doesn't have to worry about survivorship. The inhabitants don't have to belong.) The design problem is planning for continued existence. This requires exactly the kind of things we are trying to plan for. It must attract - ingather - suited fluxes and potentials, it must get rid of the undesired fluxes.

But the one property we have for all of these natural systems is that they must evolutionarily adapt to environmental pressure. That must be recognized as the 'strategy' of evolution.

If you do not want a sapient attempt at such adaption, you don't have to try. The natural sentient (in humans) strategy leaves you with about a 300-500 year cycle of life and death. The only purpose of attempting a regulatory strategy is to achieve a better fittedness to the potentials of the milieu. Perhaps after a few hundred years of such planning at the 'primitive' levels that we can at present discern, we may learn to shake down good planning.

Of course the economic - political character of society does not sit still and remain unchanged during that time. It goes back and forth, it evolves. Perhaps kings, and divine rulers, and oligarchies, and dictatorships, and democracies will appear again and again, nevertheless certain evolutionary tendencies are clear. They are associated with the totality of function possible from an abstracting sapient brain. Tools and directed manipulation of nature come first. Then speech. Then writing and ciphering. Then abstract descriptions. Then planning - cause and effectual descriptions.

So while it has been impossible to sell urban planning, say during the first quarter of this century and technically oriented urban R and D through the second and even third quarter, it will not be long delayed. Comparable but earlier stories (one-two decades) could be told about industrial planning. Any competent past middle aged R and D'er can indicate quite clear how foreign was the thought

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<sup>1</sup>Note that the notion of 'strategy' instead of 'law' arises when 'law' specifies a general static and dynamically indeterminate domain of solutions, and it is only the relative stability margin among these almost equal energetic solutions that can govern. Here we are offering a 'fluctuating' strategy of higher stability than a bounded extreme.

of being able to discuss directed planning with major company executives, say before the 1930's.

A recent article in Science 188, 916, May 30, 1975, on "OECD: Report on Research System Says the Honeymoon is Over", is an OECD report on the state of research organization and science policy in the USA. Having been concerned with the issue of R and D since 1942, we were quite pleased to see national and then international concern with R and D and policy, say as marked by OECD's entry into the field. Their resources are much beyond ours, but we believe that they still have a much more kindergarten view of the issues than ours. See for example our June 1965 report, "Advanced Technological Planning for Interdisciplinary Physical Research", AD 467 051L. The OECD report discerns one pattern and premise for USA R and D through the mid-60's, and a subsequent decline of interest.

We see a very timid beginning of R and D interest in the USA from about 1900, to a moderate thin state for American science in the 1930's, delayed by the depression, with an explosion during World War II whereupon academic appetites were whetted for the subject. The 50's then continued its Gompertzian explosion to install it within the industrial aegis. Academic noise so befuddled the issue, promising so much more than it could deliver that by the mid 60's, it was already scheduled for a turn about in Federal circles. American science had always had an inferiority complex. And, validly, American industry took on the same view (except for a few 'high technology' industries). Academia has been largely discredited as to their technological competence - they are still in process of learning about kindergarten skills - even at a time when they have become most strident.

But then the fact stares us in the face. The technical know-how and competence is essential. It is more essential than the current dominant molecularities in the western world - white, middle aged, upper middle class, aggressive males. And at present, it is shaking itself down to a small specific contribution to planning. It is not that technological R and D is dead. It is just that its total planning role has not been fully integrated. Thus at some finite rate, clearly, we are moving toward a human status where technological ideas become a summational invariant like value-in-trade. As a parameter, in transitional change, it can only be perceived dimly. Thus you can't guarantee convincing an urban area that its future survivability in man's scale, rather than natural scale, depends on technological R and D, but you can become convinced that it will have a diffusional transport associated with it.

One must note, appropriate to thermodynamic transports, that the parameter does not have to be a spatially bound transport. As an internal degree of freedom, it has to be 'transported' from mind to mind, i.e., through population concentration. It becomes physically bound to space through the convective velocities of the human.

The elites who don't want to stay you can't hold. One can examine the flux of skills and professions all through the world as various rulers have attempted to impede flow. So what we are suggesting is a better strategy. Control your

own destiny by encouraging the investment of effort (e.g., food for the stomach) to produce new or better fitting productive capability (e.g., to produce 'food' of ideas from the mind). A well designed R and D program, with known costs, can play that role.

Since the issue of planning versus nonplanning is becoming quite serious - See for example an article "A Group of Americans, Europeans, and Japanese Denounces a Call for Stronger Governmental Authority", N. Y. Times, Section 1, p. 23, June 1, 1975, or a study of a private Trilateral Commission entitled, "The Governability of Democracies", Tokyo, or a broadcast on WUHY, June 2, 1975, 11-12 A.M., World Future Society's General Assembly with its very soft terms of reference, (4 days - opening session speakers, R. Amara, D. Bell, W. Harman, H. Kahn, J. McHale, W. Bouch er) - some scientific framework has to be provided for the discussion. We will use the consideration of two organizational levels in the hierarchy of nature for our exposition. One, the question of how atoms - ions - molecules - photons (nuclear moieties - electrons - photons) can 'self' start up life processes; two, the question of how regulatory planning for highly ordered social systems - e.g., an urban complex - can come into self-existence. Note both levels have active atomisms at their base. One is the quantum dynamics of atomic processes, the other is the physiological dynamics of the living organism. But the first question this raises is how come carbon - among nuclei - 'wins' the game, or how come humans - among living species - 'win' the game? That immediately raises the answer that neither carbon or humans really win the game. Among their peers (of atoms or living species) there is no winning. They all are 'satisfied' with their role. So to speak of 'the game' requires some meta notion. That notion is thermodynamic. It is the meta notion that there is a higher level - of what - why of organization, of order. Thermodynamics is the science of ordered energetics. Without thermodynamics all the players at any one level are the same. But the thermodynamics provides the 'arrow' by which order in natural processes flow. So it is ordered structure - life in the one case, urban organization in the other - which is at issue. In that issue, carbon 'wins', and man wins. Why? Because carbon can produce greater spatial complexity by result of four equal bonds. (We don't want to provide the whole story - part fact, part fiction - for the competence). Because man has a language coordination center, he can translate among his action modalities, quite equally.

But now the problem that faces us is how does carbon win? This is a profound question. It is not sufficient to say that evolution can take place both serially and parallel. For example, one small thermodynamic engine process forms. Countless examples later, a selection process finds an example in which a second engine process has backed into step with the first (serial). Or two independent engine processes form. There is a space range in which they interact and form a complex (parallel). We require the examples, we require rates or probabilities at which the examples can occur. Then we can flesh out and believe the general principle. Commonly, we are attracted either to the materials problem (since Oparin) or the process problem (as Fox has selected in a search for pro-biological organization). Pattee has continued to stress the fantastic physical difficulty in developing hereditary reliability. We are engaged in these issues, as real engineering oriented

issues, but we don't have good answers. There is no lack of wealth of processes, only a guarantee of probability. Even  $3 \times 10^9$  years of evolutionarily available time is not a sufficient answer.

It is this same issue we face in urban cities. If we had 50,000 years of evolutionary time available, we know that planned systems would emerge. The need for higher ordered information processing would assure that. But 1 - 2 - 3 generations? No way to be certain. We might say that communist - socialist - mixed system - even technician planning has begun, and it clearly is the wave of the future, and is in process of winning. No way. The transformations are those of strategies. We are talking of systems of comparable pollence. A can fight and compete with B. In such a transformational period, we are fearful of talking about 'oughts' when we wish to talk about 'is's'.

In the long run the transformation to planning must take place to 'win' the battle of higher ordered systems. Must it occur today? Yes, but the stability margin for formation is still marginal.

At this point we have reached a critical issue. Clearly, almost by definition, neither the populace nor the bureaucrats have the essential ability to develop productive facilities. Minimally a private pecking order develops as some extended family group is taken under a leadership. Anarchic nonleadership is only possible at very dilute concentrations or at very low complex potential levels. While it is true that elite will 'temporarily' precipitate (e.g., a few generations) out of the populace, there is no assurance who and what - at least not for planning purposes. "The people will provide", is no more useful for planning purposes than "The gods will provide." And bureaucrats (e.g., keepers and regularizers of the form) can do little but regularize the forms. So it is the new ideas that are missing.

The purpose, thus, of a technical-scientific R and D is to continuously spell out, in a coherent fashion, what are the future possibilities. Thus they (engineers and scientists) can act as the catalytic intermediary between the people and the elites. Who should they work for? Preferably the people (e.g., the urban government, as part of its planning activity), but that is a premature notion whose time is perhaps only coming upon us.

Without this full fledged function in place, productive planning can only take place on a much less secure base.

But assuming its planning is in place in one form or another, then potentially the play of a market (which has been appropriately loaded with gradients) can attract, distribute, and keep both people and producer elites in the area among the potential living extensions and the producing extensions.

In this section, we are not concerned with people balance, energy balance, economic (value-in-trade) balance, even material balance per se. But we are interested in the structures and systems that have to be used for the production system to work.

Thus, in addition to people, the planning cycle has to have the flow of materials and energies. And for all of this, it has to have planning accounts for the structures - some additional (e.g., secondary) productive facilities - that are involved.

It is for this account that the transportation system has to be planned. This is one of a number of functional institutions that have to be embodied as part of the production cycle.

Man doesn't 'produce' nuclear moieties. He gets them from the ground (or sun), or at most transforms them from materials so gotten. He adds a variety of process transformations that gradually 'form' the materials that he has to store at rest or put into motion. All of these process transformations - in what will have to be a more modern accounting - are part of the production cycle. Thus transport, as a major linkage entity, must be recognized as part of the production cycle. Much more modest planning can take place whenever or wherever the links do not have to be hard geared or hard wired. Thus cities which can make do with walking or minor transport and public transport and heavy materials transport can exist at a certain level of economy to scale.

Note - from carts to multiple person vehicles - trolleys or buses - was a reasonable urban progression. The use of multiple vehicle trains seemed necessary, but, outside of its nominal manpower cost saving, its use may be still marginal. The individual automobile for large city transportation has been a serious step backward. Clearly the design problem is to reduce that usage, or at least trivialize it more. The problem is posed by the following contrasts: In the Tokyo transportation area 12 billion annual ridership for a nominal 10 million population (i.e., nominally 3 rides per day per person). In New York City, 2 billion annual ridership (i.e., approximately one half a ride per day per person), with a number that declined from perhaps 3 billion in 1945 for a 7 million population (i.e., approximately one ride per day per person). Tokyo public transportation is related to facts that only 40% of the households own a family car, gasoline costs \$1.30 per gallon, the public transportation system is fast and widespread, and cheap.

As high mobilities, we can offer the comment that whenever we go to a city with a 'good' public transportation network we automatically revert back to public transportation, e.g., in Paris, Moscow, London, New York, Cleveland, Boston, although New York is infinitely depressing. Our problem - as outsiders - is always suburban travel - except where specially designed for, e.g., Cleveland airport to town to eastern suburbs, Boston airport to town to Cambridge, Philadelphia mainline to town.

Thus home - transportation - work - shopping in town or suburban dominate our lives. And even in the suburbs, the issue of population layout with regard to transportation and stores is basic, whereupon the transportation link is to work. We are discussing our high mobile outlook as innovative middle class. We are not elites, although we hover near a border.

Having come from a much poorer strata, in our youths, we recognize the important syndrome we were brought up with. Live near good transportation, shopping, and schools. We have succeeded in the same goals in the suburbs. It is the left-behind-poor, for whom the transportation system (and schools, and stores) are permitted to rot, rather than continue to serve their needs, who then become the focal source

of rotting infection for the urban area. They are not cause of the rot. Their neglect becomes the real cause, and they play the role of proximal cause.

Thus the transportation problem is tied to the 1/3 - 2/3 of the population that have to make use of it twice each day. (Note that instead of 2 rides per day if all of a populace used it for work, only 240/360 days work days per days in year drop the level to 1.3, and if only 1/3 - 2/3 of the populace require work transportation the average level would be 0.5 - 1 rides per day for work-school. Thus transportation is scaled at higher or lower levels as groups are excluded, or included, or travel for other purposes than work-school are included.)

One can surmise that careful urban design ought to be able to cut personal transportation down to 1/2 trip per day (represented in New York by its current transportation load but with practically no cars on the streets); that much of transportation could be achieved by 1 trip per day (the N. Y. level in 1945) even with inefficient urban design; and that levels up to 2-3 trips per day is a near total population always on the move without adequate localized 'amenities', really essentials for living.

We predict that Tokyo's use of transportation will fall off, particularly as the past World War II growth explosion of the 1960's settles down and its 1970-1980 costs now have to come to a closer near equilibrium.

In addition to the productive plants (including offices, and the distributive portion of establishments - stores - that may store, repackage, or re-assemble goods), we must point to the school system.

A note is in order about the distributive system. The way things go now - whether in capitalist USA or communist USSR, or many in-between systems, all consumers have to fight their way to the stores and make their selections. With the rising costs of middlemen, let us for a moment look at the system innovatively. Suppose there is less productive gain in that distribution system than is warranted, namely if the system would operate at a lower potential more nearly at equilibrium without it, would we not arrange for an automatic distribution? Namely there are many items that are routinely required. Could they not be bought and distributed in bulk (e.g., to a neighborhood pickup point, or for that matter in bulk to the home once a week - refrigeration made the daily trip unnecessary by the 1940's.)? The required freedom (a reductio ad absurdum is the freedom to pick each grape. One of the authors, as a fussy, used to pick out cherries, the other string beans, one at a time, but note public acceptance of prepackaging. Thus the issue revolves mostly on an economy of scale) of being able to choose what you want to use or eat can be governed by feedback, once a week, month, season, year. It is only in left wing jokes that "Comes the Revolution you'll eat strawberries, whether you like them or not"! Most of us, even in the USSR, know our selection is seasonally limited. The only point is that all the time innovative economy of scale issues can be used to attempt to optimize the overall function.

As an added footnote, perhaps even more important and basic - as we write this report, we meanwhile play the role of objective planners (according to our thermodynamic construct) - as to how the system planning

is done. We believe it is an essential grasp of what division of labor among atomisms means.

If one wanted to make ensemble music, one doesn't assign each finger, or each neuron, the task of playing a different instrument. One 'temporarily' assembles some players who play in ensemble. They then leave and go about their business. They are not enslaved. They take their time and 'efficiently' divide it among tasks. Or take an even more telling biological example, of the atomisms in the living system. They enter the living system, without knowing even that they are in a living system. They are entrained into thermodynamic cyclic processes for a period (e.g., generally less than months) and then they leave. The coding for the system does not depend on atomisms being permanent members of the system.

Thus the objective planning of an urban region is achieved by the principle of economy of scale. Use two people, where more economical than one. Use a small company where more economical than a large; or vice versa. But, the basic problem, work your way through all of the summational invariants and assign all the necessary players in the over-all scheme.

For example, in starting to consider any particular urban area, we ask ourselves what is state and rate among all thermodynamic variables? We get a notion of what an extrapolation of state and rate for the next generation might lead to. We ask ourselves what rates of change might be feasibly reached. We then try to work out scientific closure balances among all of these variables. It is in this process that economy to scale arises.

For example we asked should we 'favor' small or large industry in a particular area. Here is an example of a first round strategy. Suppose technological planning suggested that the particular new development areas are desirable for the region, without necessarily specifying the technology. We would be tempted to assign the preliminary large planning notions to a number of small companies or groups, even though the suggestions came in for a rather large scale R and D or process problem. The actual implementation, we would then assign to a large company.

But the basic point is the alternation of free and bound orbits, of tossing the ball from one phase space region to another, one group to another, always selecting an optimization of scale to justify.

Every society devotes effort to the care and education of the young. Economy to scale in education depends on time and place. Clearly at present, education absorbs a large amount of an urban area's budget.

(Casual N.Y. numbers - income \$11 billion for  $10^7$  people, i.e., \$1,000 per person: Education \$2 billion, i.e., \$200 per person, or approximately \$300 per student. This indicates roughly that 1/3 of the population is in school.)

While there are fantastic vested interests in the education establishment, clearly the size of the education establishment is something that has become so



visible only in the past hundred years (as has transportation, as has health care). The question is the absolute necessity of the level and the efficiency and economy to scale.

Clearly defense costs have broken the backs of many past empires and nations. One is now entitled to wonder whether education, transportation, health care have to be allowed their turns to do so. Basically we query, what is most fitting? Clearly, as with architectural planning, we could get into the professional professional pro-con squabble, which we wish to avoid. So, at most we can stress principles.

We take as our theme a basic physiological construct.

What keeps a human society bonded is a common cultural outlook. Whether it be old, medium, or young, the epigenetic heritage (as well as the genetic heritage) passed on by parents and grandparents tends to enculturate the individual and inserts him into the society. It is necessary, for stability, that the image of enculturation which the individual sees outside (of his upbringing) and inside are essentially the same. Then, like in a zeta potential field in which many regular repetitive force centers confront the wandering individual, a well defined consistent mean free path and relaxation time forms. Wherever the individual wanders, he is faced by the same morality, the same practise, the same requirements, the same freedoms. There are no entraining double binds.

This works just as well if there is more than one class of membership, e.g., different chemical compounds, or different classes. If the different 'species' are accepted by all with a common perception, again the system can be locally stable.

And in fact to make the system work generally requires a nesting of precipitated inhomogeneous forms - institutions - that cohere in presenting the common enculturating outlook. There are specific rules for the mismatch bonding of dislocations.

Thus, for example, a nominal nesting order is family, extended family, school, religious institution, political entity. All of these then lead up to secular law - the specific rules of governance, and moral law - that which ought to govern general conduct which is given meta to the system.

Now obviously there are 20th century forces which have disrupted the chain. There are many vested interests attempting to pull social organization into many inhomogeneous forms, each which might satisfy some special interest. We are not interested in the recriminations that would be involved in identifying many of these interests. We are safe if we recriminate against our own profession. Even science is to blame. Having demolished a parsimonious basis for morality (i.e., proximal and continued intervention by a Divine Creator) less than a hundred years ago (validly to be traced to the Enlightenment and the Cartesian mechanistic revolution), intellectual thought turned to the more broadly mechanistic scientific questions. But unfortunately, again purely in a catechismic way. 'Scientific method' is a catchword. Its decorum must always be observed, whatever 'scientific method' is.

Now we believe that our science, physics, is a new religion. We have undergone a full 'mystical' conversion to that status quite recently. But note all of the trappings. We already have such a fantastic divergence from the populace,

the same populace who can only deal with beliefs on the same poverty of ideas that characterized the middle ages.

[Do you doubt this? Go into 14th Street - New York, or Hyde Park, London, or the Left Bank, Paris; or if you are very brave - Red Square, Moscow. Please start a 'learned' debate on how the laws of physics govern nature, man, and mind. For that matter, try it at a national APS (American Physical Society) meeting.]

"We don't need science", you might say, "At most perhaps we need the good practise, engineering, of the past". Fine. What practise? Norman castles? Primogeniture? Cut off the criminal's hands? No, you prefer whatever is the latest and most modern? You prefer that which has worked most often? Kings? Dictators? Democracies?

As you see, or sense, either the independence of a parsimony of assumption, science, or a godly father image remain the two poles of how to behave. Namely, lead by coherent understanding or follow by coherent faith. (Or both.)

Which brings us back to our prescription and implied definition of two person marital bonding - the ability to kick and be kicked in turn. Thus we are faced over and over again by the basis of diffusion. Be bound into an orbit, release and undergo a free movement. There are no other strategies to sense the energetics and momenta in a field.

Thus we can be faced any time by the two poles of anarchy or of dictatorial father image following, with particular eras more strongly biased one way or another. And where, at present, the many vested interests are pulling the system toward an anarchy before perhaps some more dictatorial phase comes upon us.

And that brings up, for real, to the institutional form of education. From our current vantage point we vote for Mother Church. Namely an adequate scientific basis has to be provided for nature, society, and mind.

If you are an elite and vote completely that men are domesticated animals, there is not too much education you desire them to have. If you are an unbound spirit (unbound by the laws of nature) then you may opt for the most complete education that can be gotten.

Our scientific education - for today's milieu - has been 40 years in the making. Do we want to inflict such costs on society? No, it can't be done. Academics can't teach us holistically - any more - although any one academic may still be able to teach us pieces. How can we succeed at all? The answer has always been scholastic education (See for example, S. Kramer, History Begins at Sumer, for a school boy's letter in Sumeria 5000 years ago), apprenticeship, further 'reading', self study, and master classes. The only issue, over and over again, is how does a society optimize that process.

As with transportation, the problem has again become ways to minimize the cost within a Carnot cycle efficiency.

In principle, we are driven back to an almost Aristotelian statement of the problem and its solution.

(a) Rudimentary education - mother, mother-father, or nursery.

- (b) Socializing education - family, school.
- (c) Basic specializing education - apprenticeship, school.
- (d) Deeper 'scientific' education regarding nature, society, and mind - self-study, school, apprentice citizen fora.
- (e) Extra specialized education - apprenticeship, school, directed self study.
- (f) Master education - self study, master schools, specialist fora.

If we used efficiency to scale to guide our estimate of Carnot cycle efficiency, we might suspect the following (not certain, just a suspicion);

(a) Very likely rudimentary education might be best achieved, as in Kibbutzim, among a small group of mothers, with perhaps some overlapping guidance (i.e., the more experience guiding the less). It is hard to believe that the solitary family is the best milieu for upbringing children. Thus the home or a community common room might be the facility center.<sup>1</sup>

(b) Socializing education is likely best achieved, in a real attempt to capture Dewey, not as preparation for life but life itself. The teacher is more a mother-father figure guiding the young [as a group] through socialization. This does not have to require elaborate classrooms. It can cover age ranges from 3 to 9. It can mix general socializing education, and tools. It can still be mother or father, or retired active person, mixed with some guidance teachers.

(c) Basic specializing education can continue the process of socialization as well as specialization. This perhaps requires a more formal school setup. It could take 9-13 year olds (up to the biblical age of 'manhood' self-reliance) and offer them a choice of a number of specialized socially educative lines to explore. The idea does not originate here. There has been recent British talk of permitting young people in this age bracket a number of such yearly exposures before they make up their minds. As it might be visualized in today's terms - in that 4 year slot, 1/4 to 1/2 of the time might be devoted to a common intellectual social core (namely the 3-9 year old is not going to be taught all the forms of government, whereas the 9-13 year old is certainly capable of beginning to deal with a simplified form of self government. In fact, it is very plausible that his education consist of his learning the rudiments of a thermodynamically balanced self-government. But we are not designing school operations now, so we'll put the point aside). The remainder of the time - e.g., 2-3 years, can be spent by selection of 2 or 3 tracks, such as manual and tool dexterity, family management, intellectual activities, scientific-technical functioning, dealing with people, self-enjoyment.

(d) Deeper 'scientific' education regarding nature, society, and mind. This period, perhaps 13-15, ought to be a two year service period in which the young serve a term as apprentice citizens. Namely it is devoted half to education and half to serving. The service can be to be useful, not particularly rewarding, but necessary societal functions - the collection of garbage, military or civilian policing adjuncts, court adjuncts, waste disposal, repairs and maintenance, basic building, care of the sick, care of the aged, care of the young, care of the earth. The other educational half is devoted to the theme of the positive value of social organization as the young people have seen it in the earlier practise and as they see it now as social apprentices. This again can

<sup>1</sup>(See, for example, M. Pines, "Head Head Start", N.Y. Times Mag. Sect., p.14, Oct. 25, 1975.)

be achieved with minimal facilities.

(e) Extra specialized education. Then the period 15-19, perhaps 3-4 years (or even only 2 years in some cases by choice), can be devoted to specialized education for a vocational choice. One quarter still can be devoted to social and intellectual and self-enjoyment study.

(f) Master education can then be conducted, 20-70, in suitable fora open to all qualified students.

The point of all this detail, even if idealized, is to provide some minimal Carnot cycle metric for a thermodynamically consistent educational system. Why thermodynamic? Clearly the human as a system, a living system, does not spring into being fully competent to operate. There is a long, essentially biologically determined 'educative' period. Very very minimally it is perhaps 3-4 years old (In a society that would minimally 'throw bones' to 4 year olds that wandered in the street, one would find a 'reasonable' yield of 4 year olds. But clearly they would not be epigenetically educated to take on technologically increasingly complex tasks. Such a society might persist - minimally - but it has been ruled out at least since writing and more likely since post Neolithic times, and - if magico-religious rites have any true bearing on the issue - perhaps more realistically since man's enculturation 40,000 years ago). More likely, it is perhaps 7 years (the age span with which Freud identified the full enculturation of a well formed super-ego, an image ideal for behavioral performance). But a society based on the educative process of 7 year olds, still tends to be somewhat crude. It is more relevant, since biblical times, to consider education to age 13 as providing a minimum of socialization. And in fact, one may very well consider this range 7-13 as being a realistic thermodynamic limit for human socializing education. It has been actually used most commonly throughout the entire world, even ours.

But urban centers - highly interacting division of labor centers - removed one level from basic survival, namely no longer agricultural centers, require individuals with more training. (See the picture book, Everday Life in Ancient Times, Nat'l. Geog.Soc., 1961, for a figurative taste of human function 4500-3000 B.C.). Clearly a minimum of 2 years additional training is required (as a central nervous system characteristic) in the use and mastery of tools, and more like 4 years. Thus 12-16 becomes the likely limit for urban centers.

Now we add the requirement of planned complexity and its understanding (You don't need the understanding if you only are indoctrinating a domesticated species of humans), that requires an additional 2-4 years. Thus we are forced, in modern societies which attempt to maintain technically complex interrelations (We will not speak for or against them - they are not necessary on a minimal thermodynamic level) to consider education up to 17-20.

Carnot cycle engines do not have to be maintained, but if you want to maintain them you must pay the entropic cost. And that means, in social entropy, the cost of a large amount of directed effort in education up to the range 17-20.

Thus one can sense the productive facility that must be required for education. Minimally, education can be in the local neighborhood up to age nine. (The 3-9 population is about 10% of the total population); the production domain (e.g., the center for nearly a thousand families) can center a school for the

9-13 year olds (about 8%, representing about 320 children. Since this likely does not represent an adequate economy to scale, it is more like 4 such groups that have to be coordinated. Thus some transportation is required. A student body of about 1200 would require, by today's standards, of the order of 100 'educative' personnel); the 13-15 year old group (4% of the population) needs little facility, but transportation and a fair number of supervisory educators; then the specialized 15-19 year old group (another nominal 8% of the population) requires another large scale school program. Thus in some sense, 'half' the current concentration of education facility is needed for optimal efficiency to scale. This is only a surmise, (with a public school education expenditure of the order of \$60 billion, at a cost per pupil of about \$1300, this represents about 45 million students, 20 odd percent of the population. Other populations bring the total school going population closer to the 30% implied before. We are suggesting the possibility of economies that can cut costs in half.)

The other high costs that are becoming significant in urban areas are health costs and welfare costs, and a rising cost of government.

Medical costs are perhaps \$30 per month per family, or \$360 per year. An American doctor has perhaps 600 family patients. This represents \$216,000 per year income. That likely splits (a priori) 1/4 to the doctor, 1/4 to the hospital, 1/2 to the drug industry (i.e., the drug industry would be a \$10 billion industry. So this is not-yet-a very basic theme in Carnot cycle efficiency calculations.

We believe a note has to be stressed. Health care is highly skewed by the concern of the older non-child rearing population. We are not going to suggest any ruthless 'inhumanistic' themes, but -. As China has shown with barefoot doctors, etc., there is a level of general health care which is quite adequate for the population. Exercise, modest diet, freedom from high speed stress, a large degree of work - many of the themes that Dudley White and Jean Mayer have been stressing - are the gateway to a large amount of a 'good' life. Does one have to go through a wanton life before discovering these homilies past middle age? If one stresses over and over again unlimited freedom, it seems that it tends to mean over and over again, the option of proceeding irrationally toward destruction of a higher ordered system. To illustrate, even at the level of American health care, if rational care had been our god, cardiovascular diseases would be a first on our research agenda. (See our May 1973 report, p. 126-127 for some numbers).<sup>1</sup> And second, cancer. Instead we deal quite extensively with many emotion charged modest problems. Thus it is not societal ends that are really being served in proportion to outlay. Now much of the cardiovascular causality is social stress and the management of style of life. So it is only largely cancer which is the subject of requiring 'high' scientific study.

Note the tradeoffs.

Some might react to these notions and say we are being outrageous right-wing, left-wing, academic, callous, naive - you may vote as you

<sup>1</sup>Of a 1% death rate per year, 0.4% is due to heart, 0.15% due to cancer.

please. But let us tell it our way. There has been a large publicized drive stemming from NIH for the development of 'health care systems'. Since we have a large instrument background, a large biophysical background, many pertinent connections, business being bad and our desire to be useful, we went chasing the theme.

There is a large urban city near us. Could we make connections and associations there? No. The area is dominated by academic researcher - medical teaching college - drug company interests. Could one discern a 'public' interest, where some innovative planning could be achieved? No. There was no public interest. The public - women - consumer groups - even labor groups - are infinitely naive with regard to planning.

So we turned to our own county - suburban-mixed wealth, both poor and rich. Could we penetrate? No. Why not? Penetration would require the active cooperation of the elite county medical board. Absolutely no interest in health improvement. Their own vested interest, with some, the possibility of creating a new testing facility as further revenue source, was clear. Thus we had to give up. A few giant corporations will emerge - mixtures of aerospace, existing medical structures, academic acquiescence - is the way health care systems will go.

An urban area that wants better will be hard put to develop the Carnot cycle efficiency mix that provides reasonable medical service in less than the next two generations. It will take a much greater breakdown than we have now to excite public interest.

Welfare costs are of the order of \$3000 per year to about 10% of the families in the country, so that the costs to the rest of the populace is about \$300 per year. This is not so serious in direct 'costs' to the rest of the populace. It is serious with regard to indirect costs. At that level (i.e., 10-20%) apparently the stability in a society changes. One has an equipollent mature family molecularity who possess the childish, domesticated, passive behavior of an inanimate machine but with human perceptions and skills. They begin to turn their attention to destructive outlets.

This is no do-gooder bleeding heart notion, only an objective evaluation. A September 29, 1975 New Yorker article (p.42) on "Profile of a Welfare Mother" is devastating.

Society has a variety of choices, shoot them, put them to penal hard labor, give them the choice of the dreg jobs in society, ignore them, plan to absorb them usefully into the social orbit.

All solutions except shooting them or putting them usefully into orbit causes bad social festering. Thus the Carnot cycle efficiency in any case involves a very minimal amount of productive facility planning for this function, except for the support function for those who literally have no capacity for self maintenance and there are no natural social institutions for providing that maintenance.

Currently, for example, extended health care has produced many old people, or chronically sick people, or mental defectives who can't take care of themselves. The larger family of the past (e.g., 7 children) could provide a cover

for many of these, so many didn't survive, and an even older age killed them. Now society is willing to afford the luxury but not the duty.

The Carnot cycle efficiency would seem clear. Persist as long as self dignity and drive is willing to contribute usefully toward one's own care and society, give up when you lose interest as well as capability, or when no one in society is willing to take care of you. But society is not yet ready to accept that operational notion. (Personally we are for ourselves.)

Let's put forth another thesis. In more ancient times, sacrifice to the gods for society was common. Then later sacrifice for transgression of the 'laws' of man; and we still operate with sacrifice for national 'purpose', so no one can say that such notions are outmoded. In fact, we have sacrifice for 'progress', e.g., in motor 'accidents'. Anything that kills with the precision statistics of automobiles is not 'accident'.

If we take causes of death

<u>Cause</u>	<u>Rate per 100,000</u>
all causes	932
heart disease	359
cancer	163
stroke	101
flu and pneumonia	28
motor vehicles	26
diabetes	19
cirrhosis of liver	15

clearly 30 per 100,000 never seems to be a large cause for alarm (e.g., killing 50,000 people per year in the USA). Whether one wishes to face it or not, essentially near planning decisions - hidden by expert jargon - adjusts such death rate figures. Actually, as a crude kinetic theory argument, for large sticky bulk viscosity systems, one can imagine that 10% of the existing death rate is a tolerable limit to ascribe to fluctuational 'chance'. Thus with today's 1% per year death rate, 0.1% per year death rate is tolerably hidden among expert decision making.

Note - we are providing a value-free physics - the limits. How society sets policy or strategy is not for us to say. We can no more tell our age - don't make religious sacrifices, don't make war sacrifices, don't make medically indifferent sacrifices. don't make progress sacrifices. When we do we deal with 'oughts' for society, we step outside our scientific role.

It would seem, for example, that the Carnot cycle efficiency would permit a killing rate of those on welfare of the order of 10% of the death rate. Then the welfare rate for productive facility would be of the order of 25% of the death rate, whereas the other 65-75% would be absorbed by the remainder-of-the population.

At current practise such Carnot cycle efficiency - with a 1% death rate of about 2 million people per year - would be a productive facility to take care of

1/2 million people, kill off 200,000 who are hopelessly able to live. These 1/2 million, requiring intensive care as they generally do, of perhaps 1/4 - 1/2 million at an 'expensive' level of perhaps \$10,000 per year, is a level of about \$5 billion.

The question of what 200,000 to kill, as part of a Carnot cycle offering, is a matter of policy. It is not within our scope to suggest. There are those who might impose rules of eugenics, others might say get rid of those whose social care costs the most, or the most helpless, but these are all ideological policy views. The ones who say do nothing, leave them alone, pay for them, are also expressing ideology. At least we have done our part. We have shown a Carnot cycle social efficiency.

War has a similar design philosophy. Except that defense, or perceived threat, is a major basis for design from war to war. But that design is not for the urban area to perform. The urban area can only 'vote' when it thinks the cost of examining the perceived threat (e.g., taxes for external conflict) gets too great. A priori, one suspects that, when defense costs get to 25% of the total value-in-trade, a war's disruption cannot be costlier and may resolve some issues. We stand today at \$100 billion out of a GNP of \$1000 billion. We would suspect that many are beginning to cry for a reduction, particularly since a number of external efforts have not brought costs down.

Another parenthetical outburst at this point is more related to an overall summary that fits the time and stage of writing this magnum opus of planning rather than the particular point in our writing.

1. In our ancillary work that we are doing in the command-control system for the complex biological organism, e.g., human, we have begun to realize that the routines for action, whether on the motor side, e.g., locomotion, or the sensory side, e.g., seeing, are encoded at all levels. This theme is not only being stressed to us by our noted neurophysiological collaborator, R. Llinas, very clearly in the motor and mammal control side but it can also be found expressed very well even on the sensory side by R. Gregory. See a review by P. Morrison of Gregory's latest book, in *Scientific American*, p. 123, June 1975. To be noted is Morrison's failure to grasp Gregory's basic point. He states "One stance [of Gregory's] seems wrong. Gregory thinks very little of the localization of brain function as determined by removing or making a lesion in some portion of the structure. - Gregory fails to show us engineering examples as subtle as the lesions that destroy, say, speech, but leave writing unimpaired." But this is exactly the point that Llinas and we are also trying to develop. Brain function is not sharply localized. Very extensive damage is largely replaced and taken over in the system in the order of a month. Also see the late Russian neurophysiologist, P. Anokhin's works, for example his guest commentary in A. Iberall, A. Guyton, Regulation and Control in Physiological Systems, Instr. Soc. Amer., 1973. Also see other Russian work, I. Gel'fand, V. Garfinkel, et al., "Control of Certain Types of Movements", A. Iberall, J. Reswick, Technical and Biological Problems of Control - A Cybernetic View, Instr. Soc. Amer., 1970.

We make and stress the point here because it represents the



second most profound revolution in learning about the basics of command-control of governing, regulating, controlling a complex system that has taken place in biological science. And our systems' science is still in process of learning that there is no other way than the ways that these complex systems perform their similar functions by common strategies. So social law and biological 'law' become one, and in fact merge with physical law.

2. We have tried on for size our educational plan on some knowledgeable educators. Our experience is rusty, and a decade or two of separation could have changed some age perceptions. But give or take a year boundary, we find our Carnot cycle modelling to be quite apt, and in fact quite a feasible program to model upon.

In fact one small anecdote supplied by a very experienced guidance counsellor epitomized the planning theme.

A young person was registered in a very competitive master's program which was gradually modified to bounce half the group out. This involved weekly testing, rating on a curve, and an ever increasing scope of knowledge required. The remaining students and faculty retrospectively examined who had survived. (The students did not explicitly know they were operating in a ruthless cut-throat program. That competition was necessary to survive, they knew.) Peculiarly enough, it wasn't the lone individuals who went off and tried by their own skill to read, study, and master faster all the material who survived, but those small groups who banded together, dished out fields among each other to where each individual became an expert, and then crammed and tutored the entire group in his specialty.

The moral we seemed to draw from that is that supra organization, with tight bonding and division of labor and good communication, and facilitated near coherent conduction (or diffusion) becomes the better working system, where - as McCulloch pointed out - the potential for command-control lays latent in every molecularity domain. That ties our first two themes together.

3. It is interesting that with regard to cellular communication, a recent issue of Nature on cellular communication, (p. 371, May 29, 1975), indicates recent progress. We have accepted in agreement with the field, the notion of large surface coded 'catalytic' protein molecules ( $\sim 100 \text{ \AA}$  diameter) lying in the nominal 50-100  $\text{\AA}$  lipid bilayer biological membrane. A channel through the protein permits control of admission characteristics to the inside of the cell or organelle moiety. The control is basically by electrical forces. Our recent contribution has been that control of such 'surface active' processes occurs by virtue of a rolling boundary condition. All of the detailed biological kinetics is not relevant. But now it appears that cells are not only bonded electrically by a calcium pump (i.e., electrical pumping of a particular ion from cellular interior which develops bipolar forces) but there is a protein bridge, as if the protein ball (or specialized ones) pull apart as a 90  $\text{\AA}$  diameter dumbbell with a 10  $\text{\AA}$  channel. These dumbbell 'weld' together the two large circular patches of membranes, by a close packed

hexagonal array. Thus now electrical and materials flux communications are no longer dependent on a slower solution diffusion electrically driven from communicating cell to communicating cell, but now have the possibility of an electrically gated molecular diffusive passage between cells. That process is worth 2-4 orders of magnitude increase in conduction. And as a result puts communication coherently down to the atomistic cell level.

Namely the physics of complex organization is now near explosive take-off. We are trying as fast as we can to illustrate it for social organization and higher ordered facilitated coherent operation. All this is necessary if you want to run a high ordered energetic complex organism rather than a sluggish poorly coordinated multicellular organization.

#### 4. The Manpower Supply - Further Details

Obviously we are immediately faced by a fundamental question which the Full Employment Act faced us with. Do you want your populace to work or to be unemployed? The statement was made that the Great Depression would be the last period at which such levels would be tolerated. And in fact, European countries fairly clearly indicated the achievable levels at which little disturbance took place, e.g., 2% of the working force. In the USA, by a legalistic interpretation, levels up to 5% were regarded as not essentially differing from full employment. But -

In 1975 we reached 'unthinkable' levels. We have reached a 9+% level comparable to 1941, the last gasps of the Great Depression, we have urban and minority unemployment levels at the 15-25% level. And further we have no techniques other than to trade inflation for unemployment. Many or even most people are willing to accept this level of operation a second time. We are not sanguine one can do it very many more times. So something else must be considered. So enters planning policy. (And even such trade-offs no longer seem to work.)

At this point in our development and thinking, it is useful to characterize our method of solution. We don't have hard equations. Yet we know the nominal form of our equations. Namely they are summational invariant equations plus the technology rope (technological ideas may be a summational invariant some very remote epoch of thousands of years from now) plus perceived threat level between wars. Also we know - via Onsager theory - a general theory for the transport coefficients - the first order direct couplings are the diffusivities associated with each summational invariant. These must exist, and also there are the coherent wave propagative coefficients. Then there may be second order cross-couplings (e.g., vector-vector coupling, etc.). While these must exist in some form or another they do not have to be important except in particular cases.

Now, we have a general technique to deal with such equation sets, even if we don't have them fully spelled out. It is the relaxation methods, once extensively pioneered and developed by Southwell. Start from any summational invariant. Relax that relation (namely satisfy it, in some sense). For transport coefficients, use crude estimates -

from kinetic process fluctuations, using sample data, Monte Carlo, or any other methodologies for estimate that you feel comfortable with. Go through the other equations till you have completely a ring of first round relaxations that bring you back to the second round. In this round, states are converted to rates. In trying this process, you will discover 'causality' order, which is not a priori clear. We make this assertion not from having learned it here but from having learned to use relaxations for the thermodynamic equations of hydrodynamics, i.e., for the turbulence field. The theory is related to a theory for repeating decimals. It is as if a number of generating series for a number of repeating decimals are coupled. The order of making the relaxations is 'causally' connected within the relations, but they are not obvious. Thus the limited number of relations makes the process finally discoverable.

We are developing a counter model to the Forrester model. Namely it is a network model; it can only deal with a war to war period for a near autonomous moiety; it stresses that complex systems must be regulated and controlled at every organizational level in a nested fashion; and it stresses that all and only those variables that are summational invariants are to be treated.

We have little doubt that in less than a decade all other models - e.g., Forrester, Mesarovic, Wharton, Brookings - all could be fitted within our construct. Our claim is - but not conversely. And of course our basic claim is because we have two fundamental themes built into our construct. (1) The physics of statistical mechanical ensembles. (2) The basic strategy of systems, the biological principle of ontogeny recapitulates phylogeny. (See A. Iberall, F. Yates, "Physiology and Physical Overview of Regulation and Control - Thermodynamic Guidelines", 1975 AAAS presentation; A. Iberall, "Cybernetics Proposes a Thermodynamic View of Brain Activity", in press 1975-1976.)

But, as one can see, given a productivity level for the urban area the manpower supply has to fit. And as we have indicated, the 'cultural' issues beyond economic, are professional status and ethnic status. In order to make the mixing pot society cohere, there is a dual nature that must be dealt with. The separatist status has to be recognized, and its diffusivities have to be sufficient that there is an easy common flow of essential fluxes among them.

In England, the older process was a class society where each knew its place and knew how to cooperate with a common view. In two or more phase hydrodynamic fields - mobile molecules - pressure and temperature are uniform throughout. Namely momentum and energy are equipartitioned translationally, not necessarily inside the 'molecularity', whether chemical or a liquid cell. The solid state is too congealed. Here is the absolutely most basic point. The solid state of immobile molecularities is too congealed. It is only the fluid state that will support complex organization.

Now we don't propose that the English two-class know-your-place solution is the only one. Colonialism has suffered a tremendous blow in the past decade. But acceptance of a common perception is essential among the inhomogeneous functional structures that make up complex

systems. So there must be ethnic recognition, just as there must be elite recognition, just as there must be professional recognition (professional is a poor term, we mean the molecular organization - what you do. This forms a community of common interests and tasks and perceptions). But there must be an easy flow among them so that at some longer relaxation time atomisms can move among these classes. (With a Hebrew background, it is quite difficult to consider wiping out of one's heritage. But more cynically, we know that heritage has had a changing perception of itself and the world. And that more dilution and drift away takes place than the individual might recognize. But this remains over and over again the issue - of what is an elite and how fast must he be turned over. It turns out to be the same problem as biological turnover.) At the present, in Boston, elsewhere - the South having already largely made its peace - desegregation is being attempted. Being horribly against segregation, with ample proofs if required, and having been involved in vanguard attempts to destroy segregation, and now the issue of having reached more conservative middle age, we are more concerned that 30 years, pre-Brown to present, has not made the class problem more miscible. Race as well as a few other minority differences has gotten worse rather than improved. And in fact these problems are very intimately tied up to the issue of urban settlement and planning. So it is not that we are in favor of the separatist Boston parents, as much as we are in favor of our society, our cities, Boston, New York, etc. The present story - fire bombings in the South Bronx, N. O'Gorman, "The Children - Who Will Save Them from Unhinged Families, Inert Agencies, Mean Streets?", N.Y. Times Magazine, June 1, 1975; P. Wilkes, "Jobless, in the Suburbs", N.Y. Times Magazine, June 8, 1975 - of anomie (estrangement), antagonism, conflict - is not the basis for harmonious integration in a complex system. It may remain near equilibrium locally, but its boiling and bubbling boiling and troubling, makes the energetics for the whole system quite costly. Or conversely - the more important way - for the given energetics, the operative state is rather impoverished for too many of the atomisms.

So the basic easing required is any way by which the various compartmentalized moieties 'see' each other. Namely permit an easy flow of unimpeded empathetic bonding exchange force. The thread in man beyond the rudimentary physiological recognition of species member to species member is the human competence to form values, not the specific form that it took in post-Neolithic societies of value-in-trade. Note value was an intensive variable before post-Neolithic times.

(Intensive quantity, e.g., temperature, total pressure - a parameter or variable which ultimately has a common metric when two statistical mechanical ensembles are brought into intimate contact. A relaxation time delay takes place before the equalization occurs.

Extensive quantity, e.g., entropy - a parameter which partitions when two ensembles are brought into contact. Roughly the partitioning has a mass specific property for each homogeneous phase.) Namely, humans brought together had shared perceptions - of magico-religion, of hearth gods, of the use of tools, of fire, of some taboos, of belonging to the group.

Yet after post-Neolithic times, value-in-trade, the abstraction formed in the mind, became an extensive quantity. This is the most amazing discovery made yet in the thermodynamics, the physics of social ensembles. It brings value (and the entire philosophic apparatus that has plagued intellectual thought for 3-5 millenia) within thermodynamics as an essential matter rather than a boundary, peripheral, artistic matter. Clearly there have been many efforts in the 'oughts' of society, to bring values, ethics, morality within a scientific circle with no success.

Specifically religion, patriotism, 'reason', utilitarianism, magic, mysticism, love are all somewhat near intensive parameters that societies have weighted in the balance as extensive parameters and have not succeeded. The near universal intensive metric of religion, of belief in one God, has come nearest supplying that kind of variable, but clearly it has begun to come apart. The epigenetic progression of magic, mysticism, hearth god, gods, one God, autonomous mechanistic reason, parsimonious reason as science has swept across man's horizon. Perhaps only 'now' - in the next few thousand years - the progression may be retread again and again. In any case, the problem we have just discovered is very difficult, and it will require a great deal of Talmudic thought and deliberation on our part before we understand it well as physics. (We of course have made our bias clear. Science, physics in particular, is our new religion.)

The problem with a specific value rather than a general value is similar to the pleasure principle. 'Value' as an intensive quantity strikes us as a unified measure like Freud's libido or temperature. In a kinetic theory, we finally find out that temperature is a sum of kinetic energies among equipartitioned degrees of atomistic freedom. We have troubles when there are delays in that equipartition. Formal form emerges out of the process. Libido has a similar measure, not as purely 'genital' energy, but as a measure of equipartitioned 'pleasurable' energy among all channels. Now we suggest value has that same character.

If we refer back to our essay, "On a Neurophysiological Basis for War", we identified abstraction really as the equipartitioned formal circulation of an electrohydrodynamic 'vortex' through all sensory modalities which was so transponded by the coordination center and so diffused in the limbic system of the brain. Namely it was effectively equipartitioned and so recognized as an abstract speech element. 'Value' was that abstraction which could fill the brain space with a strong enough multidimensional flux that it could serve as a hydrodynamic forcing impulse for action.

The polar regions of the neuroendocrine and neural system so space filled? Love, respect, duty, awe, and perhaps a few others, namely these are complexes formed out of the simpler emotional state. Love - 60% sex, plus the millions of words used to describe it. You want 'clinical' descriptions? Sweating palms, inability to speak freely, blushing, etc. All of these part attempts indicate physiological concomitants, but with a loose overall integrative complex. The state is bound out quite tight; it is not quite so clear what all the fluxes

and switch states involved in the entire state.

So perhaps it is not possible to decompose the intensive parameter - human value - into its polar pieces with any precision. Somehow all the other part states are only parts of having a parameter of human value - for the one, for the blood bonded, for self, for social molecularity, for social system, for a fetish symbol (e.g., the flag stands for rather than is the nation). Does it boil down to the fact that value must always have global dimensions, i.e., it must sample many domains, and has to have at least some minimal super-natural character? Namely, therefore, are such universal religion historians as Toynbee basically right in their historical pursuits? Is the issue that to bind an urban area together that it must share an intensive quantity - human value - that will cut across economic level, profession, and ethnic level? We would believe yes. So one question is how does planning help to enrich that?

The rational answer is why don't you see the other groups point of view, see their enduring needs, join hands to produce some covariant bonding, some exchange force. But that is not strong enough. So it requires much more catalytic process in the system to promote the pair bondings that lead to human value. And religion has never been strong enough to have a universal bonding. Generally it is a hoopla combination of all, all the equipartitional components - sex, religion, love, awe, magic, external super ego formation (i.e., relinquishing of self command-control), assertiveness, the gift of tongues, - by which human value emerges as a bonding potential. Charismatic leaders as well as demagogues know how to manipulate these equipartitionable avenues. Enough as an introduction to the intensive parameter.

How does value transform into value-in-trade an extensive variable?

We will talk out a description. It is not certain that our talk is yet physics.

With precipitation in place, there is still the need for inter-community communication. Else each system would operate independently. That, apparently, they could not, and as we are indicating they still cannot. So in order that they be able to communicate, they must share a near common temperature. Ordinarily - among atomisms, molecules - one has the radiation field to share temperature. Hence there are too many things to transport - materials, energy, people, momentum modalities. The shared value energetics was not sufficient in range. It is a close range binding. At long range, you are a stranger. If you are willing to marry and to share the total energy modalities, in time you can be admitted and share. But if you have to be free to come and go, you cannot share the human value potential. So at most you have to carry it as a bit, i.e., proportional to slower convecting number of atomisms. And that property of making human value - with its possible different levels - begins to make it into an extensive variable, one proportional to the number of a member of a homogeneous species, i.e., the number of traders. But in that case they don't have to have exactly the same temperature, and they begin to trade in terms of chunks of that potential, in terms of symbols rather than the internal vortices that repres-

ented human value. It was a concomitant of language itself, namely it becomes another language. And if you want, it even takes on the Marxian character that the nature of the tradeable social relations depends on the mode of production. More important, read F. Anders, "Teaching the Retarded", N.Y. Times Magazine, June 1, 1975.

It is conceivable that human value is another summational invariant although we have no full sense of its basic time scale. Namely in human encounters, day by day, generation by generation human value is conserved. Note that value-in-trade becomes not only an extensive variable from center to center, post Neolithic, but it becomes such a variable internally - it doesn't have to, but it does. Thus the older notion of an intensive value becomes at least partially an extensive notion of internal values within each person which also can be shared. 'Suddenly', people do acts that are not measured by value-in-trade, either positively to aid flows, or negatively to impede flows. Thus perhaps there is a half idealistic - mystic component, an additional relaxational relation that expresses how the growth rate of human value takes place within the urban center. Clearly when the people don't cohere (have much shared value) it is very difficult to get things done. So these are all issues that appear prior to thinking about the distribution of manpower.

For the sake of the record, these are the kind of problems we see relevant to New York, and Boston, and Philadelphia, and we are willing to do our part in dirty works, in free works, etc. to advance the cause. Where do you want us to register, or to appear?

A point far removed from this theme but yet quite relevant to the issue of value, or shared value, as a common intensive metric that binds a society together is very much in the air in the current milieu. This is related to rise and fall of civilizations.

We have suggested that civilizations have a rise and fall period of the order of 500 years. We have made no effort to offer an underpinning theory for the process, although we have been reading and are involved with a study of civilizations group. We have surmised since beginning to consider the question in about 1947, that the USA has peaked in about 1950 (The Marshall Plan period can be considered our high water period). After that, as the beginning cumulation of the rape of our resource, as the incremental cost in total materials, etc. i.e., in the total entropic burden we place on our resource to persist, the downhill process has begun. This became increasingly clear to us by 1960. But it would be exaggerating to say that we had any gut feeling, anything more than an intellectual perception of the problem.

By the way, the fact that we had peaked did not mean that further rises in standard of feeling could not take place. And, in fact all kinds of locally highly encouraging signs might have been read, e.g., the breakdown of segregation, Lyndon Johnson's State of the Union address calling for the Great Society and an end to poverty. (In our opinion, shared with one lone person, Wayne Morse, this was the greatest message of the American era. It is somewhat ridiculous to see the fantastic range of extremes in LBJ., this most complex leader.)

But we had never lived through a decline and fall period, or its beginnings. It has become infinitely shocking to us how rapidly the process could take place. We really did not believe we were watching it in the 60's. But by the end of the 60's and midway through the 70's, with two decades of retrospect 1955-1975, wherein in the mid-50's we asked who would win the struggle for Big Science and could spell out the victor, to now, we can complete the social chain and ask who will win control of our society and where will power pass. We believe the perceptions of decline are quite real. And the surprising, shocking thing we see is the issues of loss of will, confusion, questioning of who we are. Some telling examples? We know that we face an energy crisis. We find a Congress and Executive Branch that between them can't get on the ball and do what has to be done; a situation where decisions cannot be made because each local electorate has different reactions, and our politicians feel they have to give in to get re-elected. No progressive leadership arises from the populace to lead with clarity. Instead pettifoggery and potential dictatorships are encouraged. There is no way to capture the common will, a common value to move the system as a whole.

The point in this exposition is that the intensive notion of value likely is a summational invariant that develops generation to generation (it is passed on epigenetically as a value system from the total milieu - parents, grandparents, schools, neighborhood, religious institution, TV). Note that in the recent milieu, large shifts have taken place. Even though people are living longer, the grandparent role is less, even the parent role is less, the neighborhood role is greater (peer group - more leisure time for the young), even the school role is less, the religious institution is largely down, and TV is alarmingly up.

Thus clearly (now - if one wants to fault us for stupidity, they may, but these are very difficult problems. For the first time we now see that pre Neolithic man already had the summational invariant of value as a thermodynamic variable. Thus he was already different from other biological species, even in his mammalian family, or his primate order. Then with precipitation-in-place through agriculture, the dual split to make intensive value an extensive variable value-in-trade also took place.) value is an additional summational invariant that has right hand transports that represent its left hand change.

And the perception we are alluding to now is the long term changes in values that take place in the decline period of a civilization.

For those mechanist, idealist, reactionary, radical, conservative, liberal, or even just confused man-in-the-streets, we would tend to stop at this point and say, look if you're confused, go take the following dose of reading. (It's not a perfectly thought out list, but top of the head, yet it will illustrate the basic point). Please rush off and read, The Basic Works of Aristotle; Kant; Engels, Anti-Duhring; Monod's Chance and Necessity; Forrester's Urban Dynamics, World Dynamics; Harris' The Rise of Anthropological Theory; Joos, Theoretical Physics; Morowitz, Energy Flow in Biology. Then come back. (We are probably the only physical scientists in the world who, at the same



instant have Engels, and Joos both open on a desk for a serious dialectic examination of their primitive thoughts, as serious science.) Do you see any unified ideas among all of these sources that you can deal with? Yet what we have offered you, in this reading list, are the threads of reason that attempt to bind phenomena together. Is it the one, the few, or the many? Obviously as physical scientists we have to stress again and again and again that we have such few forces - electromagnetism and gravity to bind it all together. (For those who wish to pray at the very most up-to-date wall, please read S. Weinberg, "Light as a Fundamental Particle", Physics Today, 28, 32, June 1975). And, for persistent systems, we have no other methodology but statistical mechanics. So reader, of whatever persuasion, if you don't like our 'classically' directed statistical mechanics, provide your own. This is not an idle rhetorical challenge. We can fill in the names of at least a half dozen investigators who could mount a creditable challenge. But we ask any who wish to grasp the issue that they must understand some of the background of development from Newton, through Maxwell, through Gibbs, through irreversible thermodynamics. Beyond that, who is profound and who is naive requires much more examination. (One can read Engels' Anti Duhring, or Wetter's Dialectical Materialism to sense how earnestly Engels for example took eight years, he says, to study the details of science.) Good, bad, or indifferent, regardless of how one feels about Marxian dialectics, one should keep that in mind, Marx and Engels made a considerable effort to understand and encompass science within their system. How they might or might not have biased their perception is the same issue of profundity or naivete that always exists. Those social scientists, or even physical scientists, who want either to challenge Marx or to challenge us had better begin the task of the necessary erudition. All of these outbursts are directed to the one question. When systems begin to have difficulty in running, e.g., whether because of poor initial design or because they are approaching a more terminal degradation state, how much does an operator or maintenance expert have to know to keep it running? As R and D'ers, we have always opted for a deep rooted scientific base. Most others consider the minimal need to know to turn over the next cycle. It is an ancient and honorable disagreement, but somehow in (or during) that disagreement, systems rise and fall.

Very well. We now surmise a thermodynamic variable - value - idealistic, in the mind, one that can dissipate into chaos and is not always on board. Is it dangerous to conceive of? Yes, but no more dangerous than for man to learn about fire and heat and temperature and how and what it takes to control such a Promethean variable. Does any one doubt that 25 years of R and D seeking sustained fusion reactions is any different?

So, value is an additional variable. Its metric has to be defined. It is a sticky variable, contributing to the bulk viscosity. Namely as Herzfeld describes the temperature delay portions of internal fluctuations as contributing to the bulk viscosity, so that all molecularity regions do not equipartition energy, so common values are not immediately shared between groups - e.g., men and women, ethnic groups, racial groups, young and old, populace and elite. Thus equilibrium in less than a generation doesn't take place; more likely it is the 3 generation

period at which near equilibrium takes place. But what constitutes the shared value system then is a peculiar thing. It is a perception that each group knows its place, not that all are equal. (Very rarely that may be the outcome.) Or at least, the time scale of which each group nearly knows its place is the near equilibrium social time scale - at this moment the unique determinant of social equilibrium - and we still believe as an initial surmise that this is the 3 generation time scale.

Thus for urban 'network' planning of the one generation time scale - e.g., Boston desegregation - one must count on a large deviational disparity among groups. Note that pressure in the south has shown a fair relaxation, 1950-1975, a little more than one generation. Thus the value relaxation is a fundamental issue.

Thus TV (or whatever is the most intrusive communicational system - would you like to have had to compete with Hitler's or Stalin's or Mao's or Kim Il-Sung's addresses) becomes the most powerful instrumentality for coordinating the process. From the 30's on, the agit-prop of Communism, then the Big Lie of German fascism set our teeth on edge. "Oh Lord", we would ask, "Isn't there away that reason can counter such streams of hogwash?" And the answer was "No". And in very basic ways, that question of the 30's, and that discovered answer has furnished a large amount of impetus to our desire to study the mind of man, and human society. (Note two of the themes that Marx - Engels proposed for dialectics, the third being nature, but that was the study from whence we came.) And we were even more disturbed when we began to see a large growth of managed news in the USA. While that managing wasn't as humanistically evil - it wasn't used to kill millions of people - as the Communist - Fascist style, it was worse in that it made mockery out of our Age of Reason, Age of Enlightenment Constitution, our search for a path for man to control his own destiny.

We still desire that democratic end, but we are kineticists. We do not believe in agit-prop, Big Lie. We do believe in accenting the positive, reinforcing a common workable shared perception. This might be considered shading the truth. We don't know. We know that independent of ideology, this compartment will be manipulated. So all we can do, is suggest desirable strategies or optimal strategies for our humanistic - democratic ideology. Others can suggest theirs.

Our strategy would consist of reducing discord to a shared value system with minimal action (energy deviations and time). In that sense, we are proposing a Hamiltonian least action principle. It may be that the system operates that way already, namely that this is the equivalent of a Newtonian dynamics extended and elaborated for society. But in that case the use of such a strategy would be in accord with 'natural' law, or at least furnish the bases for a Ziebolz model. Namely, like a Rayleigh-Ritz program, we could consider specific n adjustable parameter trajectories between valid end points and optimize the parameters for nearest fit. Thus our intention is that a physically parallel Hamiltonian program built around the value parameter is our answer.

We would suppose anticipating our more formal results that the Marxian counter would be that the emergent least action shared value system is part of the superstructural resultant of the existing mode of production. But our counter is that the value system (say of the elite) permits selection of new technology paths which can change aspects of the mode of production. Thus the value system is not totally superstructural, but is to be found intimately coupled to the base productive system.

One might suppose that a larger scale 'ecological' strategy, if we were Mother Nature, might be so say wipe out the human species and reduce the entropic costs of that species. That issue we don't understand. Perhaps Mother Nature really already does that and we are just superstructural excrescences on her modes of production. Thus, in any case, at most we can only come up with human oriented strategies. Of course it begins to gnaw on us intellectually that that strategy now begins to involve paying serious attention to Mother Nature. But we can still hear our elites holler if and when we say the theme.

On the other side, imagine asking portions of the populace to cool it, or suffer benign neglect when their perceptions for change, for betterment of status are readied. (We are personally and intimately engaged in such a game in which one perceived minority is small business R and D versus A, B, C, D, etc.).

So there must still be a cautious putting on of the harness of science or claimed science in these arenas. It is not that we disbelieve our themes, it is only that we can't guarantee that a particular strategy is a law.

Thus Ziebolz modelling.

## Summary

In the preceding portion of this final report (Part II) a hierarchical systems construct of a thermodynamic nature was offered for the socio-economic system in which its institutional needs, particularly transportation, was embedded. And the scale was then focused on an urban policy system model. In this report, the spectral characteristics of the urban center - at the level of the family, the functional organized units of society, and the essential compartment balances of the urban center - are spelled out in greater detail. These compartments are food, materials, energetics, manpower, productive function, economic balance, technology, and governing the system. Ideal 'Carnot cycle' efficiencies are characterized for the basic cyclic processes in each compartment.