The Strategy of Urbanization

A Preliminary Review of the “World Problématique” and the Club of Rome's 1972th “Limits to Growth”

Pierre Bélanger
Associate Professor of Landscape Architecture, Harvard University, USA

Currently, global densities, overall, are in decline, as world populations are increasing. As auto-
mobility continues to rise, the net effect is a gradual reduction in the spatial density of urban areas
and an increase in the size and diffusion of their footprints. Today, cities are outgrowing legislative
boundaries taking on new configurations, and forming new zones, regions, and territories. Urban
populations are naturally sprawling. These proven ground conditions contradict the common
assumption that compactness, verticality and high density provide pathways towards sustainable
urban form. Instead, when seen from continental or coastal scales, the current reduction in urban
densities proposes a new lens on urbanization as a set of processes that are necessarily incomplete,
unfinished, uneven. Patterns of horizontal and geographic urbanization are distinctively yielding new
urban geographies and landscape infrastructures at unprecedented scales, beyond the borders of
political states; boundaries that have been inherited in past centuries from colonial control, imperial
planning, military warfare, industrial development and land use engineering.

Departing from the early work of urbanists such as Jean Gottmann (Megalopolis, 1957) and
Benton Mackaye (The New Exploration, 1928), the distinctive horizontal patterns that characterize
the world today is force-effect-&-process, simultaneously, and has produced a new generation of
geospatial urbanists today: through quantitative evaluation in the work of Shlomo Angel ("Making
Room for a Planet of Cities", Lincoln Institute of Land Policy), qualitatively by Joel Kotkin ("Urban
Legends: Why suburbs, not cities, are the answer", Foreign Affairs), technologically by Jack
Dangermond ("Geodesign", ESRI) and geographically by Neil Brenner ("Planetary Urbanization",
Urban Constellations). Together, with a rising group of next generation urbanists - suburbanists,
super-urbanists and disurbanists - this contemporary horizon on urbanization is moving beyond the
notion of cities as the focal point or central place of urban development, as historically advocated by
macro-economists such as Ed Glaeser or Richard Florida, once expressed through the holy trinity of
streets, blocks and buildings in conventional, Old World urban design. Instead, what is emerging are
geographic infrastructures, urban ecologies and landscape economies emerging from processes of un-
planning and de-legislation. This new, geographic landscape is fuelled by the agency of terrestrial and
biophysical configurations that allow the fluid nature and force of decentralization to generate
unprecedented synergies and flexibilities that respond to the dynamics, dimensions, hazards, risks,
and indeterminacies of contemporary urbanization: global mobility, fluid water systems, waste
ecologies, resource cycling, food cultivation material markets, and migratory cultures for the 21st and
22nd centuries.

Revisiting the key concept of the World Problématique proposed by the Club of Rome, and of
the World Model by the System Dynamics Group at MIT that authored The Limits to Growth in 1972,
the following notes present a preliminary review of the fundamental, and often extreme differences in
systems views which have, so far, led to skewed a understanding of the urban condition through its
problematization. Referencing Lewis Mumford's 1956 The Natural History of Urbanization, this
review is a case study of contemporary urbanization that specifically proposes to contextualize and
compare the original research on systems by Jay Forrester (MIT Engineer, World Dynamics, 1971)
that underlies the Club of Rome's world view, with Howard Odum (Ecologist, Systems Ecology, 1973)
and Abel Wolman (Engineer, Metabolism of Cities, 1965). Moving beyond the Club of Rome's original
formulation of the World Problématique and its "List of 50 Continuous Critical Problems" originally
published as part of The Predicament of Mankind, this review proposes how the notion of
urbanization can be understood through an ecologic optic, that opens a more complex, more fluid,
and more nuanced characterization of urbanization - as strategy - for responding to the predominant
processes of population migration, changing climates and resource economies, today.

From this platform, urbanization is no longer a 'problem', a condition to be minimized,
controlled or arrested, but rather it is a strategy of ecological and economic consequence that needs
to be discovered, designed, directed and deployed. Here, horizontal spread and terrestrial sprawl in
their largest sense—either through the sustainability of slums or the urbanization of the oceans, can
be understood as some of the most intelligent and flexible processes in the history and future of urban
civilization.
The fundamental problem with urbanization is, that we consider it, a problem. 
At the core of the discourse on compactness, and the restriction of urban development is the characterization of urbanization as a problem that should be regulated. Through the underlying notions of footprints, boundaries, and densities, the growth of planning - urban, rural, regional or otherwise - as a scientific, social discipline in the past half century has been one of the most important instrument to control and legislate compact growth.

Synonymous with centralization, the perceived benefit of compactness has persistently received support by proponents of environmental protection and sustainable development. Yet, for the most part, some of the underlying precepts of compact growth – its origins, assumptions, undertones – are reviewed seldomly. While considerable efforts could be made to date the idea of compactness as historic subject in and of itself, the purpose here is to look at threads and thoughts that underlie compactness as a premier canon of environmental discourse in the late 20th century. In the context of current concerns over the environment, the singular reliance on the affiliated concept of footprint reduction as a spatial factor in the discourse on sustainability remains unchallenged. As a counter position, the aim is to re-evaluate its value, and establish cause for alternative practice. By looking at the process of decentralization, we can expand our repertoire of under recognized strategies for contemporary urbanization.

Whether it was perpetuated through design disciplines from the School of Urban Design in the 1960s (growth of cities through the triad of streets, blocks, and buildings) or, through preservation paradigms from the School of Resource Conservation in the 1950s (conservative consumption and resourcefulness) or, through administrative bureaucracies from the School of Planning of the 1940s (municipal incorporations and land use zoning), or through organizational theories from the School of Military Planning prior to the 20th century (spatial concentrations, centricities, fortifications), the principal assumption of compact growth implies five self-reinforcing and paradoxical conditions:

1. Compactness relies on twin measures of footprints and densities, despite the fact that urban densities are largely in decline, while populations continue to increase and migrate across borders.
2. Compactness is controlled by instruments of legislative policies, political boundaries, power structures, while zoning remains one of the most powerful instruments of development yet remains difficult to change in response to the shifting conditions of rapidly growing urban agglomerations or slowly declining industrial economies.
3. Compactness depends on centralized configurations, infrastructures, hierarchical subdivisions which puts into question the very existence of non-formal, extra-legal developments across the urban world that exist without, or in spite of formal planning mechanisms.
4. Compactness perpetuates broad and generic land use oppositions between what is urban and what is non-urban (rural, regional, peri-urban, suburban, pastoral, industrial), yet everything should be qualified across an urban gradient.
5. Compactness produces invisible externalities that, when revealed, demonstrate the intrinsic processes of production, distribution and consumption, such as food sheds, energy structures, waste streams, material flows that are inherent to patterns of urbanization.

In the past two decades, environmental agendas have uncritically equated the notion of compactness as synonymous with sustainable development. In turn, the environmental logic behind compact urban growth - smaller spatial footprints, centralized configurations - has been naturally associated with lower carbon footprints, lower resource consumption rates and reduced population growth rates.

Growth through Demographics
In combination with outlooks on resources and demographics, the environmental premise of compactness has relied on the twin concepts of containment and carrying capacity which, through the object of the city, reinforce an anthropocentric perspective of urbanization. Sustainability, then, is a factor of compact 'human' growth over all other forms of development. By this measure, New York - Manhattan, really - became the symbol of sustainability in the mid 1980s after claims "the city as the greenest community in the world." By comparing the density of a 250-year city on a small island bearing the highest land values in the world, as the barometer for the remaining 300 million people living on the main land, the explicit deployment of density as a denominator was unknowingly sealed as the comparative basis for urban development. As measure and metaphor of compact growth, "everywhere should be more like New York." Furthermore, by placing human development at the center of the concerns of sustainable urban
development, the flawed and skewed notion of the environment (an anthropocentric cul-de-sac)\textsuperscript{37} established a hierarchical sense of human entitlement, above and beyond all other forms of life and resources, while fostering a linear sense of material fatalism and catastrophic dogmatism that was, for the most part, portrayed as irreversible.\textsuperscript{38}

**Inventing the Environment**

These unquestioned understandings originate from several lineages of environmental thought, whose most recent expression is the 1992 Earth Summit in Rio de Janeiro. In the *Rio Declaration on Environment & Development*, a plan for the 21st century was proposed, "Agenda 21", that placed "human beings at the centre of concern for sustainable development."\textsuperscript{39} Later touted as "The Earth Summit Strategy to Save Our Planet", the *Rio Declaration* appeared novel in its universality. After all, it was a political milestone. It demonstrated how the transcendental nature of the environmental subject, sponsoring solidarity across nations during the Cold War Era through shared, transnational, transboundary, issues of pollution and poverty.

Although *Rio* was a high point, it was not an end, nor was it a beginning. It was part of a long line of environmental conferences underway for well over two decades. *Rio* reaffirmed what its two predecessors, had already adopted during the two previous decades: in Geneva, 1987, with *The Report of the Brundtland Commission* titled "Our Common Future", and in Stockholm, 1972, with *The Declaration of the United Nations Conference on the Human Environment*. *Rio* was simply "to build upon it."\textsuperscript{40,41} Lauded as world’s first gathering of nations on the topic of the environment, a major contribution of the 1972 Conference was its focus on the effects of urban development: emissions and effluents, poverty and pollution. Under the *Environmental Issues Project* already underway since the mid 1970s, a strong bias was being formed by twin conceptions of equilibrium and carrying capacity.\textsuperscript{42} At its core, the 1972 *UN Conference on the Environment*, was influenced and shaped by a report published for the 1972 *UN Conference* in Stockholm by a team of scientists at MIT, *The Limits to Growth*.

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**The Limits of Limits**

As part of *The System Dynamics Group*, the MIT examined "the five basic factors that determine, and therefore, ultimately limit, growth on this planet - population, agricultural production, natural resources, industrial production, and pollution".\textsuperscript{43} The book itself was actually a report that formalized a proposal written for two interrelated purposes. First, it was launched to establish the ideological platform of "an informal, non-political, multi-national group of scientists, intellectuals, educators, and business leaders,"\textsuperscript{44} the umbrella organization of the Club of Rome. Second, it proposed a series of scenarios related to perceived global problems, a "world problématique", that would require the development of new world policies. Presented in book format, and later translated into 32 languages worldwide, with over 12 million copies sold today, the primary audience for the report were policy makers, and heads of state.

Addressing the so-called problems of unplanned and unchecked growth, imminent resource scarcity and growing social imbalance, *Limits* was an alarm bell amidst a more fragmented world, more than two decades after Alfred Sauvy, the French demographer, coined the term *Tiers-Monde* ("Third World").\textsuperscript{45} Global inequalities were being depicted by the Cold War split of industrialized nations, and *Limits* placed itself in the middle of a major social, technological and economic divide whose progress threatened mankind through over-production and over-population, with the potential of overshooting and outspasing available resources in the long run. Alarmist and projective, the predicted scenarios of over-production and over-population modelled cataclysmic levels of pollution, plummeting food availability, and ultimately, result in mass starvation and death, over a period of 150 years.

When *Limits* was published, the year 1972 saw the transformation of a generation into a digital, global era: the world just saw its first microprocessor in 1971, the first Earth Day was celebrated in 1970, Neil Armstrong walked on the moon in 1969, and photos of the Blue Marble were brought back to Earth a
year earlier from Apollo 8, in 1968. *Limits* was also published a year before the 1973 Oil Crisis which greatly contributed to its cause, in addition to the visibility it received during the 1972 UN Conference. From then on, *Limits* became the background and ideological frame that supported future arguments for the protection of the environment, resource conservation and sustainable development.

Originally written by a group of American and European researchers—an environmental scientist (Donella H. Meadows), a political scientist (Dennis L. Meadows), climate scientist (Jørgen Randers), and son of an oceanographer and naval officer (William W. Behrens III), the group's intention was to explore logical, systemic models through a combined set of world trends. The world system was modelled on resource consumption, population growth, capital investment through industrial development, extrapolated through to the year 2150. In short, the book was the proposal for a model, a way of seeing and perceiving complex conditions and develop alternative pathway of development, assuming that current conditions were both untenable, and/or unsustainable.

**System of Systems**

Through the application of system dynamics by a pioneering group of MIT scientists, the authors exhaustively developed a series of scenarios at which such points would be reached, and when it be projected to happen. Implying irreversibility and potential catastrophe, the predictions and modeling procedures provided considerable insight into the complex correlation between the process of industrialization, use and overuse of resources, population growth, agricultural development and the effects of pollution. In short, *The Limits* was entirely based on the notion of future irreversibility:

"In the making of such an effort, the factor of time has acquired the utmost importance, for rapid change which is a crucial aspect of our technological momentum is accompanied by a parallel phenomenon; the similarly rapid and massive crystallization of any corrective action we devise and apply to the situation. If our initial surmise that such partial curses are either insufficient or irrelevant is correct, it follows that such action exacerbates the problématique as a whole and adds certain irreversible features to it. This, then, must lead us to conclude that time is not only of the essence but an absolute imperative that must condition any undertaking which seeks a new approach to the dilemma of our age."

From the paradoxical characterization of *Limits* as a "Intellectual Bombshell" to a "Models of Doom", *Limits* received considerable attention. It was critiqued and supported from both sides of the environmental protection/human development debate triggered for the next forty years. But, in order its premise, several other, important reports, proposals and publications must be included as part of its assessment, and its antecedents. The subtitle of *Limits* reveals both purpose and lineage:

*A Report of the CLUB OF ROME’s Project on the Predicament of Mankind*  

While *Limits* is recognized as a milestone in environmental literature, emerging from a decade of environmental alarmist discourse, the relative success (in terms of exposure and recognition) was actually the reaction to an earlier proposal to the Club of Rome. Published two years earlier in 1970 by Hasan Özbekhan and Alexander N. Christakis, the proposal was originally authored as *The Predicament of Mankind: Quest for Structured Response to Growing World-Wide Complexities and Uncertainties*. As a prospectus, the $900,000 proposal was written with Aurelio Peccei, an Italian industrialist who, as a result of the proposal attempted to underwrite to projects on world problems by the Club of Rome with the actual proposal writers themselves, Özbekhan and Christakis. Based in Geneva (Switzerland), its primary funding came from several corporate sources, but the original proposal was specifically written for Battelle Columbus Laboratories, a technological think tank headquartered in Columbus, Ohio with affiliations in Geneva. With deep seeded aspirations tied policy making and urban planning, the formulation of problems and the identification of root causes, were the end to a means. Reduced to a simple problem of logic, a simple solution (or set of solutions) could be found to almost any type of complex condition.

**The Problem with Problems**

With the recent awareness raised of “our place in the universe” as *Time Life Magazine on The Year 1968* broadly proclaimed, the core of this catastrophic assumption for the future of the Blue Marble - this Malthusian dilemma were two important premises: that the resources of the world was limited, thus the world was reaching a peak, and second, that any form of solution to the problem of scarcity and pollution, should be universal. Both of these premises hinged on the notion of carrying capacity, and together with fear of nuclear annihilation at the height of the Cold War, and views of the Blue Marble from outer space, a global view of the world emerged as a closed system, on the edge of potential collapse.
The problematization of urban conditions started precisely with "The World Problématique", itself.

To reach this perspective, it was the original premise of the problematization of ‘urban’ problems, the universalization of all these different problems, through the central underlying notion of the World Problématique. Better known as the "macro-problem", or "meta-problem", the conception of the problématique was specifically formulated by the Club of Rome in preparation for a major world conference the 1972 UN Stockholm Conference on The Human Environment, at the time of release of Limits by the MIT System dynamics Group. Not only was it foundational to Limits, the notion of the World Problématique reached all the way to the United Nations, and was inherited, if not assumed in future conferences, when in 1987, Gro Brundtland, as UN Secretary-General and head of the World Commission on Environment & Development, reported to the General Assembly in Our Common Future (1987), was accompanied with a note presenting it as a "report on environment and the global problématique to the year 2000 and beyond, including proposed strategies for sustainable development."

It was The Predicament of Mankind, and its specific enunciation of "The World Problématique", that provides the original formulation and how it was later disseminated:

"It is the aim of this particular project of the Club of Rome to turn the above assumption into a positive statement, trying to cognize and investigate the all-pervasive problématique which is built into our situation, through some new leap of inventiveness." 67

Not only was the problématique outlined in its pages in a broad sweeping message, it was itemized and illustrated in a 49 bullet-point list, titled "Continuous Critical Problems". The problems ranged from 'explosive population growth' (No.1) and 'widespread poverty' (No.2) to 'uncontrolled urban spread' (No.4), 'irrational agricultural practices' (No.35), and 'growing technological gaps between developed and developing areas' (No.39).

Symptomatic and reflective of chronic itemization of solution at the time, the list was a conflation of problems enumerated in two previous publications from where the concept and notion of the problématique actually originated: Hasan Öz békhan's Toward A General Theory of Planning written between 1967 and 1968,69 outlining 28 different "Continuous Critical Problems" and Aurelio Pecci’s The Chasm Ahead. Both texts outlined and described, in great detail at longer length, these problems through infrastructural inadequacies, social inequities, and material imbalances, as part of a future-scenario, planning practice through the lens of a one-world system.70
Whole with Holes

Considered again, the interrelated notions they conveyed - universality of effects from national policies, disequilibrium of environmental conditions, finitude of resources and reliance on the world as a singular whole and closed system - were central to Özbekhan and Peccei's combined formulation of the notion of the world problématique. Furthermore, in *Predicament*, the world problématique was graphically generalized and visually isolated to demonstrate its logic. Borrowing from the visual Venn method that show possible logical relations between a finite collection of sets, *Predicament* illustrated the Club's proposal by showing the growth of isolated problems that, after a certain scale, begin to overlap and form cores of problems. Once aggregated, this problem within other problems could then be addressed with larger macro-solutions. The positivistic outlay of problems in *Predicament* would then lead towards the formulation of solutions, a crystallization of policy-based approaches, reinforcing binary oppositions between good and bad solutions that would substantiate the social-scientific basis of planning already underway. For planners, it was prophetic.

Influenced by its own technological positivism, *Limits* inherited and absorbed Özbekhan & Peccei's thinking (without their direct influence), equating solutions through technologies and policies. The structure of their work invisibly reinforced the structure of political economies that remains contested today. As it was seen, one set of solutions could be devised to address ‘the whole’ of the problématique. Considered altogether, aggregated all at once, the approach would supposedly and eventually lead towards a rebalancing of sub-systems through re-calibrations.

From this utopic, holistic equilibrium, several holes can be exposed. Across two major axes of thought, the associations and representations of the MIT Project Team unknowingly carried out two, underlying assumptions:

**Problems need Solutions**

With an exclusive focus on policies and technologies as solutions to carefully delineated problems, a specific focus targeted political economies, thus defining nations as the unique and privileged entities through which action could be conveyed.

**Planet as World System**

By modeling the planet through a continuous system of inputs and outputs as its primary mode of representation, the notion of balance was at the focus of recommendations that placed conservation (through resourcefulness and compactness) at the center of the future equilibrium.

The Future of the Future

Together, these assumptions point towards other holes, revealing a fundamental flaw in the original premise. They reveal natural flaws and imperfections that result from the structure of understanding a group of problems in and of itself. Largely developed by engineers and scientists, with roots in electrical engineering and social sciences, their systemic approach to the urban problem, required isolation or aggregation of variables. Yet, in reality, spatial models resisted pure, rational or quantitative simplification, let alone comparison to problems associated with electrical networks. After all, the models that the MIT Project Team were largely based on the work of their professor-mentor, and electrical engineer, Jay W. Forrester.
With his graduate students, it was Forrester who developed and operationalized theories of system dynamics. With applications across a range of scales, his simulation software like DYNAMO, and World3, provided the models to work complex parameters and subsystems through non-linear relationships and feedback look structures. Although the computational power of Forrester's simulation work is significant, it was the magnification of his ideas - the scalability of system dynamics - that is most astonishing. Within the space of a decade, Forrester was working at three scales: the industrial, the urban, to the world.

In 1957, Forrester initiated research funded by the Ford Foundation to develop methods of Industrial Dynamics (1961) "as a way to understand and to design corporate policy". Forrester had been working for almost a decade with the US Navy on the development of SAGE, the Semi-Automatic Ground Environment, a radar detection system for intercontinental ballistic missiles, research that was radically more extensive than the Manhattan Project. Originally based at MIT's Lincoln Laboratory, research for SAGE researchers like Forrester moved to the newly-formed MITRE Corporation, where systems engineering and advanced technologies led to the invention to ARPANET, and continues today to be developed for critical national problems, and a range of surveillance, control and air defence systems.

By collaboration with Mayor-of-Boston-turned-Consulting-Professor-at-MIT John F. Collins in 1967, Forrester was invited to extend his approach by applying system dynamics at the urban scale. Following the publication of those results with Urban Dynamics in 1968, another door opened for the testing of system dynamics at the global scale. After an invitation from MIT colleague Carroll Wilson, Forrester joined a symposium with the Club of Rome in Bern Switzerland in the summer of 1970. Cautiously capitalizing on the failure of the project proposed by Hasan Özbekhan and Alexander Christakis, Forrester convinced the Club's Executive Board with alternative model using system dynamics to respond to the World Problématique and reformulate the problems outlined in The Predicament to Mankind that were originally developed by the founders of the Club. In less than 12 hours, on the returning Swissair flight between Zurich and Boston, Forrester had already drawn up a sketch for the structure of world dynamics. By the time Forrester touched down in Boston, a working model was ready within 36 hours for the incoming team of Club's boards of European executives. After 3 weeks of presentations on the theory and applications of system dynamics, the project would then be funded for 300,000$ by The Volkswagen
Foundation. Two publications followed: the self-published *World Dynamics* by Forrester less than 8 months later which explained the prototypical world model, and *The Limits to Growth* published by his students, the MIT project team of the System Dynamics group in the summer of 1972.

![Limits to Growth, cover and back](Source: Potomac Associates, 1972)

**Engineering to Urbanism**

When viewed as an urbanist, the progression of scales in Forrester's work is useful to consider. The relationship between the corporate and the urban scale seemed since cities were quickly being incorporated as legal entities since the 1920s. On paper, cities emulated corporations in their structure: hierarchical, multi-divisional, and bureaucratic. But spatially and socially, cities were undergoing considerable change. Large cities, or human settlements as the United Nations called them, were exploding (Bangkok, Lagos, Mumbai) with an explosion research on megalopolises and conurbations, while other cities, industrial metropolises, were imploding with labour disputes and industrial abandonment (Detroit, Milwaukee, Toledo). Visibly, the model of urban planning was falling short due to an outgrowth of regulatory boundaries, an inflexibility to adapt to rapid change, and incapacity to maintain existing infrastructures.

This skewed perception, between perception and reality, was the real crisis. Since perception underpinned the structure of models, it also influenced. Urban planning simply could not, cannot, adjust to the pace of real time changes. And since large multinational corporations - from Volkswagen in Germany to Battelle in the US - were underwriting the research of the Club of Rome, the relevance and applicability of the research seemed unquestioned, if not perfectly natural. After all, the Club's view of the world was an industrialized optic emerging during the Cold War—on the brink of nuclear annihilation, hinging on the problems of the non-industrialized other, The Third World.

**Dynamics, Difficulties**

Forrester gained tremendous respect during the Cold War for his foundational work on ground radar systems, and for his invention of the random-access magnetic-core memory (RAM) at the base of computing today. Although his pioneering research on theories of system dynamics were widely read but much more difficult to implement. Despite his wide-ranging experience on the ground, on the farm and at sea, "the exercises" as Forrester called his books on system dynamics, "were easy to compute in the lab, easy to develop at the university but much more difficult to apply in the field". For corporate policy makers and city organizations, system dynamics were complicated, hard to understand and to incorporate as part of established practices. Outmoded thinking was Forrester's obstacle. At urban scales, the application of his modeling methods and systems theories resulted in no actual, physical projects. The future of system dynamics was more pedagogical, through educational programs.

**Systems & Patterns**

Possibly, cities - let alone the whole of the world - just simply did not function like circuit boards. Nor could they built in the same way. The intelligence of system dynamics, found in its strategies of accumulation and modeling of storage mechanisms and feedback loops, that were inherited from Forrester's work on memory chips and computing power were the main contributions of his work. But the brilliance of digital innovations at the core of Forrester's work, also resulted in a technocratic optic of urban society, and inherently had its own limits. After all, style, design, perception, opinion, media - albeit seemingly unquantifiable and subjective, whether it was wrong or not - mattered. During a period of considerable social transformation and economic shift in industries like automotive manufacturing and cities like Detroit, Newark and Philadelphia in the late 1960s, the basis for system dynamics and for future scenario planning,
it seemed, was problematic itself and represented considerable complication in actual implementation. Both praised and controversial, Forrester's world was, like his systems, closed.

The History of the Future
The closed world however, had a context. Nearly simultaneously, in 1969, The Future of the Future, John McHale was endeavouring into the design of the emerging trends, where technique and technology was a product of human ingenuity and material design a resource in and of itself, action-based through design. Citing the work of Buckminster Fuller, Bell Labs, NASA, McHale was eyeing the tremendous transformation brought upon by automation. Visually, textually and graphically, McHale acknowledged the latent contradictions of military innovation and civilian technical uses, forging a path towards the design of a planetary society\textsuperscript{91} that did not necessarily require a holistic, catastrophic or harmonious perspective of the planet, nor did it resort to problem solving or utopic equilibria. Instead, The Future of the Future proposed a lens on trials and errors, on innovations and accidents, on visual and spatial complexities, on live species and inert materials, seen through advances such as weather forecasting, climate visualization, remote sensing techniques, and satellite systems. For McHale, this advancement was produced by the conflation of human and environmental forces, urbanism as part of a globally complex ecosystem.\textsuperscript{92}

Decentralization & Diffusion
The regionalization\textsuperscript{93} of urban conditions also offers a path to move beyond the problematization of urban conditions itself. Jay Forrester himself acknowledged that non-linear methods of thinking about systems required first and foremost, that making a laboratory model "one should not attempt straightaway to solve a problem."\textsuperscript{94} In support of de-problematization of the urban condition, in favour of more in-depth study of agglomerations or disaggregations, it was regional urbanist Howard W. Odum who, at the beginning of the 20th century, was closely observing the critical diffusion of cities,\textsuperscript{95} and their transformative patterns. With an eye from the American South, Odum wrote about overlapping ecological, economic, or social regions through the characterization of flows and processes:

"The significance of regionalism as a technique of decentralization and redistribution is reflected in an equally wide range of examples. Some of these are basic to the decentralization and redistribution of population, of industry, of wealth and capital of culture, of social pathology, and of bigness, complexity, and technology in general."\textsuperscript{96}

From the Personal to the Planetary
Often poorly understood, the global phenomenon of urbanization was, and still is one of decentralization and deruralization. It represents a shift from the industrial economies of supply of the early 20th century towards the economics of demand of the 21st century. This “flattening of the density gradient” is an expression of the levelling of socio-economic structures in the 20th century. Largely responsible for outward movements of cities, and reduction of urban densities, it is a process occurring across “a more dispersed landscape [that] has afforded many people greater levels of mobility, privacy, choice.” The increase in individual purchasing power, increased personal mobility, and personal communication made possible by network technology systems have thus contributed to a horizontal pattern\textsuperscript{97} of urbanization that functions largely as an alternative to the “densely settled cities that were the norm at the end of the nineteenth century.”
Openings & Indeterminacies

Seen from a geographic scale, the urban gradient presents unseen movements of capital, new markets and new economies, porosities and the dissolution of political borders. It presents a different spatial model, a map upon which territories, geographies, or systems are porous that instead of being closed, are so large, and so complex that in fact, they take on the proportions and processes that emulated the behaviours of open systems.

Systems to Ecologies

The work of systems ecologist, Howard T. Odum, and hydrologic engineer, Abel Wolman. Odum derived a series of models for transformed natural systems through flows and exchanges, with specific orientation towards the basis energy. His work was later applied to constructed urban conditions, never differentiating human beings from other species, nor their environments, in difference to the typical, more anthropocentric models of the time.

Odum also understood complex systems, as inclusive of both capital, and pre-capital processes of transformation. Ironically, it is during the atomic age, that his work was initiated for the Atomic Energy Commission (AEC) at the Nuclear Center at El Verde in Puerto Rico (PRNC). Between 1963 and 1970, the project was part of research on the effects of radiation and gamma rays on plant life specifically, and forest systems broadly, an ecological stress-test on a tropical rain forest where pine trees served as bio-indicators given their sensitivity to atmospheric radiation, "mineral cycles, metabolism, and operations of the complex living systems structure, by concentrating new and old techniques."98

Moving beyond the metaphors of systems circuitries from the fields of electrical engineering, the PRNC project provided a foundation for introducing notions of ecology, emergence, indeterminacy. As precursor to his work on systems, Odum demonstrated how linkages, loops, associations worked, in tremendous detail, spatially and graphically. Maps, diagrams, aerial photos, charts would provide the multimedia through which systems learning could be compiled and communicated. Odum’s visualization offered open-ended expressions of systems. Pioneer of ecological engineering, Odum's methods were scalable but also and easily applicable: “control mechanisms in the complex forest may serve as innovative models in planning the future of man and energy on earth, a problem in the topology and transients of energy-network design.”99 His methods of modeling energy flows provided pathways for better understanding external forces and externalities. Odum's method helped to understand how complex systems worked, how they are changing, and how they can be modified. Beyond scalability, he understood how systems needed to change structurally over time, through substitution: "systems in nature are known that shift from fast growth to steady state gradually with programmatic substitution, but other instances are known in which, the shift is marked by total crash and destruction of the growth system before the emergence of the succeeding steady-state regime."100 From this open-ended, ecological optic, Odum was less interested in the problematization of urban conditions than to its study. Odum later revised his Ecological & General Systems: An Introduction to Systems Ecology in 1994, adding a section on urban regions, widening a lens on the complexities of urban economies as ecologies.

Figure 8: Organizational Formats: Networks by Paul Bahran (1962), Systems Ecology by Howard T. Odum (1983)
Source: RAND, University Press of Colorado

Metabolism

Another, earlier observer of the openness of urban systems, was the hydrological engineer, Abel Wolman. In the 1950s, well before the Club of Rome, Wolman advocated for a more fluid, material and chemical understanding of urban processes. With specific attention to flows, especially effluents and emissions, he proposed the systemic design of water management. In his 1965 Scientific American article "The Metabolism of Cities", he outlined:
"The metabolic requirements of a city can be defined as all the materials and commodities needed to sustain the city's inhabitants at home, at work and at play. Over a period of time these requirements include even the construction materials needed to build and rebuild the city itself. The metabolic cycle is not completed until the wastes and residues of daily life have been removed and disposed of with a minimum of nuisance and hazard."\(^{101}\)

**Flows & Fluids**

Wolman focused on three urban flows: water supply, sewage disposal and air pollution. Beyond a mere theory, this metabolic landscape was an operative lens on urban processes through their materialities, fluidities and chemistries, as well as through networks of flows, reflows, and treatments. That fluid optic proposed how infrastructure – as a spatial, fluidic medium – could go beyond the techniques of problem solving, and actually begin to build cities through their expansion and their continual design. Like Odum, Wolman also correlated the relationships between sources of materials and sinks, between resource mines and wastes, between energies and synergies.

**From Problématique to Project**

Together, the systems ecology of Odum, and the urban metabolism of Wolman, point towards the requalification of the "urban" through processes, as urbanization. They move beyond the mere assertion of solutions, beyond the limits to growth,\(^{102}\) and instead establish strategies, expressed through morphologies, relationships, gradations, synergies. Waste ecologies are its best example through an infinite multitude of backflows, overflows, reflows, leakages, impurities, spillovers, discards, disassemblies, material residuals, secondary energies. Whereas urban form may have historically been expressed through the design of streets, blocks and buildings during the Beaux Arts or City Beautiful Movement, Odum's synthetic view of ecologies open the potential for the design of urban flows, where fluidity in and of itself, generates form. As a consequence, the pluralization of ecological knowledge contributes towards a renewal of interest in the basic, indivisible flows of urbanization: waste and water, food and fuel, flora & biota, mobility and energy.

**Models to Maps**

The ripple effects across these urban ecologies are recombined areas of knowledge such as in the fields of ecology, energy, economics, as well as design, planning, engineering. As the operative notion of ecology expands today, the early work of systems ecology in the 1970s is finding new relevance. Innovating a pluralistic interpretation of ecology, the work of systems ecologists such as Odum or metabolic thinkers such as Wolman, for example have come to expose the skewed, scientific positivism of linear, closed systems that, thanks to systems engineers, have contributed to the prevailing misconception of the 20th century: urbanization as problem. Through flawed notions of carrying capacity, growth limits and resource scarcities, visions of world apocalypse and environmental destruction perpetuated in the late 20th century are dissipating through the representations of urbanization as fluid, circular and strategic, thanks to more nuanced, multi-dimensional understanding of urbanization. The fantastic, planetary visions of technological fixes pushed by systems engineers to "solve" the urban problématique, aided and abetted by classic Newtonian positivism, is beginning to fade under the more calibrated knowledge of systems ecologists.\(^{103}\)

**Geographic Urbanism**

In this expanded, ecologic understanding, urbanization then becomes a field of shared, polyvalent practices as opposed to a specialized, or exclusive discipline such as engineering, architecture or urban design. As the vertical, hierarchical differences between engineering as technological discipline and ecology as a scientific subject break down, a new design agency emerges. Combined, the effects of the fin-de-siècle recuperation of the geographic subject from the den of military hibernation and the emergence of ecology out of the exhaustion of the environmental lobby are exponential and earth moving.

**Control to Design**

Cutting across the disciplinary divides between ecology and engineering, we can understand the structural potential of ranges and types of systems, or sub-systems, between closed and open systems, including their flows, their materialities, their economies. Thus, the *World Problématique* and the problem of the urban becomes a question, "how do we support urban life? Consequently, it presents a line of greater, more projective questioning about the ecologies of urbanization, geographic of real-time information, and flexible infrastructures:
Moving beyond the footprints of cities, how can we find new ways to map patterns of decentralization through the recognition of new infrastructures, ecologies, and geographies?

Responding to patterns of consumptions, accumulations, and exchanges, can we enable design-on-demand, live feedback and real-time decision-making that correspond to?

Engaging to emerging planetary risks, can we design new spatial flexibilities and landscape infrastructures?

**Systems to Landscape**

Moving beyond notions of compactness and density, by which we currently define and measure cities, we can propose several contemporary characterizations and directions:

**Altitudes & Extents of Urbanization**

In contrast to the planning of urban areas through the medieval orthodoxy of plans, patterns of urbanization can be best projected in section, revealing new dimensions and extents, from the bottom of the oceans. While population increases but growth rates taper off, we will not only have to plan for its spread, its waste, but also for its growth and its shrinkage. From processes of sub-urbanization to super-urbanization, from the underground to the orbital, we will have to design infrastructural distributions and dispersions, to design and support the world we live in.

![Figure 9: Altitudes of Urbanization: Submarine Cable Systems, Lower & Outer Satellite Orbits, Space Junk (2013). Source: OPSYS/Sara Jacobs](image)

**Material Economies & Waste Ecologies**

As materials scarcities, both inert and living materials go hand in hand with material ecologies and economies, so will material substitutions and cycles increase, leading to perpetual markets of material substitutions, always be in motion and circulation. The task of urbanists should therefore be to ensure the design of these material flows and pathways, through their vectors and these volumes, their logistics and landscape that extends these material longevities in addition to the technological substitutions already underway. In the urban world then, materials become part of a metabolic system, that produce other materials and require other energies that may present certain resource endpoints, but enabled by infinites of use and limitless programmatic substitutions.¹⁰⁴

![Figure 10: Material Economies: Shipbreaking Yard, Alang, India Source: ©2011 Carrie Teicher](image)
Littoral Landscapes & Flexible Infrastructures

With nearly half of the planet's population living on coasts and shores of continents, the redrawing of the contours of cities within pre-existing hydrological formats - deltas, estuaries, lagoons, river mouths, gulfs - these urban landscapes can be seen as the building block of oceans, the breeding grounds of marine life, which provide us a littoral vantage to see the city for the sea, the land for the water. Facing changing climates and the tropicalization of the planet, the shifting economies of dry land that have formed the basis of trade and exchange in the 20th century give room to wet, fluid ecologies that provide concurrent, and simultaneous spin-offs: safety and security, ecology and economy, for health and wealth.

Figure 11: Flexible Urbanization: Makoko Fishing Village & Okobaba Sawmill, near Third Mainland Bridge, in Lagos, Nigeria

It is from these different characterizations, conjunctions, crossovers, across a spectrum of multiple urban disciplines - between ecology and engineering, geography and planning - that the ecologic optic emerges. Located in between intellectual jurisdictions, this optic brings together a series of strategies that present the landscape of urbanization, including its geographies and ecologies, as a conflation of complex processes, natural and constructed, risks, and hazards, across several scales, simultaneously.

Figure 12: Risk Landscape: Distribution of Storm Shelters & Evacuation Systems, Coast of the Bay of Bengal, Bangladesh, in the South Indian Tropical Storm Basin
Source: OPSYS/Alexandra Gauzza

Through the synthesis of ecology and infrastructure together, this position proposes ways to engage urban culture beyond the dogma of growth, industrial production and scientific logic alone, beyond the World Problématique, transcending the economies of scale that have regulated the shape of urbanization during the past century. Together, these characterizations provide pathways to reformulate original problems identified from urbanization - the strategies of spatial decentralization and disciplinary reconfigurations - manifest through political denationalization and the weakening of states, new spatial distributions and zones of cultivations, technological diffusions and social equities, cross-border mobilities and we may in fact begin to see that sprawl, decongestion, abandonment, as supreme manifestations of decentralization, are some the world’s most important if not inevitable spatial strategies,105 across different dimensions of urban life, from planetary infrastructure to personal action.106,107
world. The key to New York's relative environmental benignity is its extreme compactness. Manhattan's population density is the most significant measures, New York is the greenest community in the United States, and one of the greenest cities in the world. See "Dilemmas in a General Theory of Planning" by Horst Rittel and Melvin Webber, in Policy Sciences, Vol.4, No.2. (June 1973): 155-169.

21 In "The Practical Significance of Decentralization" (The Journal of Politics, Vol.36 No.4, Nov.1974: 958-982), Norman Furniss proposes that "this question gains relevance in the context of current concern over the environment, the depletion of resources, and the dysfunctions of endless growth. In general one can posit that the more decentralized the power, the less attention to environment or its improvement.

Furniss lays out the eight key arguments for reconsidering decentralization as an extremely viable and multi-dimensional strategy. Furniss also cites the work of Lennart Lundqvist, "Crisis, Change, and Public Policy: Considerations for a Comparative Analysis of Environmental Policies" European Journal of Political Research Vol.1 No.2, June 1973: 133-162.


23 The confused association between density, sustainability, footprint and compact growth has been perpetuated by the misunderstanding of the complexity of urban economics addressed in the often-cited 1974 study "The Cost of Sprawl" prepared by the Real Estate Research Corporation (RERC) for the Council on Environmental Quality, the Office of Policy Development and Research, Department of Housing and Urban Development, the Office of Planning and Management, Environmental Protection Agency. In the report's conclusion, The results of the study, presented in more detail in the tables that follow, show a surprising consistency: "planning" to some extent, but higher densities to a much greater extent, result in lower economic costs, environmental costs, natural resource consumption, and some personal costs for a given number of dwelling units. These results do not necessarily hold for the development of a given land parcel." The RERC cautions that "the results are not directly applicable to any specific development, either existing or proposed. The features of a particular site or community substantially affect the magnitude of any of the costs. Nor should the results be interpreted as recommending one type of development over another. There are too many costs and benefits which have not been included, particularly those associated with questions of personal preferences and the revenues generated by different development types. But the analyses should provide local officials with a better information base about the impacts of different development patterns, allowing them to make better informed decisions about the future form of their communities." (6) Critiques of this often-cited report, and the dangers of misinterpretation and over-simplification include Duane Windsor's "A Critique of the Costs of Sprawl" (JAPA Vol.45 No.3, 1979: 279-292) and Richard Peiser's "Density & Urban Sprawl" (Land Economics Vol.65, No.3, August 1989, 193-204).

24 Exposing the paradoxical nature of our use and understanding of environment, Jesse Ausubel proposes that we that we are Exposing the paradoxical nature of our use and understanding of environment, Jesse Ausubel proposes that we that we are liberating ourselves from the environment and that the environment will in turn liberate itself from us. See "Liberation of the Environment" Daealus Vol.125 No.3 (Summer 1996): 1-17.

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26 In "The Practical Significance of Decentralization" (The Journal of Politics, Vol.36 No.4, Nov.1974: 958-982), Norman Furniss proposes that "this question gains relevance in the context of current concern over the environment, the depletion of resources, and the dysfunctions of endless growth. In general one can posit that the more decentralized the power, the less attention to environment or its improvement.

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31 The more recent premises of compact growth originated in the 1990s from London (UK), with its North American equivalent in San Francisco (US).


33 Elizabeth Burton, Mike Jenks, Katie Williams (ed.), The Compact City: A Sustainable Urban Form? (London: Spon Press, 2004). According to Ambrose A. Adedayo, "it is in this context that compact city form has been punted as the main way of promoting sustainable human settlements in both the developed and the developing world. The concept Is to an extent premised on urban containment, to provide a concentration of socially Sustained mixed uses that will concentrate development and reduce the need to travel, thus Reducing vehicle emissions. As such the compact city concept is premised on environmental sustainability (reducing the carbon footprint) and socio-economic sustainability (providing of social and economic close proximity. See "A Tale of Two African Cities: Hyper Growth, Sprawl and Compact City Development" (Working Paper for 48th ISOCARP Congress 2012) www.isocarp.net/Data/case_studies/2172.pdf


35 In a broad and generic perspective, New Urbanist Peter Calthorpe claimed in 1985 that "the city is the most environmentally benign form of human settlement. Each city dweller consumes less land, less energy, less water, and produces less pollution than his counterpart in settlements of lower densities." See "Redefining Cities," Whole Earth Review (March, 1985): 1. In a 2004 article of the New Yorker, "Green Manhattan: Everywhere should be more like New York", David Owen elaborates: "By the most significant measures, New York is the greenest community in the United States, and one of the greenest cities in the world...The key to New York's relative environmental benignity is its extreme compactness. Manhattan’s population density is more than 800 times that of the nation as a whole. Placing one and a half million people on a twenty-three-square-mile island sharply reduces their opportunities to be wasteful.”


37 Exposing the paradoxical nature of our use and understanding of environment, Jesse Ausubel proposes that we that we are liberating ourselves from the environment and that the environment will in turn liberate itself from us. See "Liberation of the Environment" Daealus Vol.125 No.3 (Summer 1996): 1-17.

38 In "A Brief Hermeneutic of the Co-Constitution Of Nature And Culture In Me West Including Some Contemporary Consequences" (History of European Ideas. Vol.20 No.1-3, 649-659, 1995), Eric M. Kramer explains the classic origins and linear causality of crisis thinking in lieu of differentiated understanding of models and ranges of outcomes. "Obviously, to speak of 'growth', 'limits', 'chaos', 'time', and things 'ahead' presupposes a spatial metaphysics manifested as causal linearity: materialistic fatalism. The crisis mentality that sells so well is a consequence of the post-Renaissance Western perspective that peculiarly is traceable to the modern spatial metaphysics that is presupposed by the current discourse, crisis has become a permanent condition. The modern is obsessed with control as exemplified by the rise of the 'cult of efficiency', technology valuation, and 'scientific management', as well as the dominant philosophy of will expressed by Arthur Schopenhauer and Friedrich Nietzsche. The flip side of an obsession with control is expressed by a fear of fear-the terror of hysteria. This side of modernity is best traced to the modem spatial metaphysics that is presupposed by the current discourse, crisis has become a permanent state of human condition. The modern is obsessed with control as exemplified by the rise of the 'cult of efficiency', technology valuation, and 'scientific management', as well as the dominant philosophy of will expressed by Arthur Schopenhauer and Friedrich Nietzsche. The flip side of an obsession with control is expressed by a fear of fear-the terror of hysteria. This side of modernity is best expressed by Sigmund Freud's obsession with this 'illness'. Since the Renaissance, the perspectival mentality of the West has..."
been intensely preoccupied with the conquest of space. This has also included the attempt to spatialize, and to control
time."[649]...It is important to recognize that the Christian eschatology spawned a sense of linear time that leads to a dead end. Since this mentality emerged, each generation has believed that it is in a 'crisis'. This belief in impending doom has been combated both on a spiritual and physical level. Physical science has been the favored tactic for control since the rebirth of Aristotle's thought (Renaissance) in the West. "[650]

37 Nineteen-seventy-two was a moment of ideological convergence and environmental apothecosis. The UN Conference in Stockholm was largely the child of several other conferences that were formulated in Europe by the United Nations and in the United States by the Aspen Institute. For example, the 1961 Aspen Institute Conference (premised on "The Climates of the 11th and 16th centuries A.D." by H. H. Lamb), was arguably one of the important conferences on the modern notion of the environment in the United States. It would later shape important thinkers, and be referenced in other, future venues: The Aspen Technology Conference (1961), UN/WMO Conference in Rome (1961), Les Changements de Climat (1965). See Judy McLemore, "Total Quality Management General Systems Theory And Marxist Theory-Praxis" Vol.1-4 (Herndon, KS: Institution for Authority Research, 2002). Nevertheless, Stockholm was built on the foundation of an important document co-written in 1972 by British Economist Margaret Ward ("Spaceship Earth", 1966) and French-American microbiologist René Dubus ("Think Globally, Act Locally", 1980) titled Only One Earth: The Care and Maintenance of a Small Planet. Precursor to the Earth Charter, the unoficial report by Ward and Dubus was commissioned by Maurice Strong, then Secretary-General of the UN Conference on the Human Environment in Stockholm. Regarded as the architect of the 1997 Kyoto Protocol, Strong was the Canadian power broker who is regularly credited as the founding father of the modern environmental movement. Canadian multi-millionaire Maurice Strong was the Founding Head of the UN Environmental Program (precursors to the IPCC), Board Member of the Chicago Climate Exchange (the greenhouse gas emission registry reduction system ), Director of the Aspen Institute, Senior Advisor to UN Secretary General Kofi Annan, Senior Advisor to World Bank President James Wolfensohn, Chairman of the earth council, Chairman of the World Resources Institute, Co-Chairman of the Council of the World Economic Forum, Member of Toyota’s International Advisory Board. For more information on Maurice Strong, see "Al Gore set to become first carbon billionaire" (New York Times, 2009).
42 The 1973 Oil Crisis had nothing to do with resource scarcity. It was not an oil crisis inasmuch as it was a crisis in political control of resource flow between the West and the Middle East that led to an 'Oil Embargo' placed on the U.S. by Arab Members of OPEC. However, the embargo did expose the fragility of several Western economies that exclusively relied on petroleum for major economic sectors and industries such as transportation, energy, defense, electronics, and manufacturing. For a more in depth understanding of oil as both geologic resource and political commodity, see Giacomo Luciani's "Oil and political economy in the international relations of the Middle East" in Louise Fawcett (ed.) "International Relations of the Middle East" (London: Oxford University Press, 2004).
44 A few of the examples include: Cole's Models of Doom: A Critique of the Limits to Growth (New York: Universe Books, 1972), William Nordhaus, "World Dynamics: Measurement without Data", as well as counter critique by Jay W. Forrester himself, "Response to a Paper on World Dynamics by Nordhaus" mimeo D-1736-3, February 26, 1973. A more personal reassessment of the limits concept is Paul Krugman who worked for William Nordhaus as a research assistant at Yale University, see "Limits to growth and related stuff" The New York Times (April 22, 2008). The original authors of Limits published their own review in Limits to Growth: The 30-Year Update. One of the original authors, William Behrens III, was not part of the 30-year update, since, according to Jay Forrester, Behrens has abandoned the ideas of Limits to become a potato farmer and seller of non-electric household appliances.
45 The authors of Limits published the book with the following dedication: "To Dr. Aurelio Peccei, whose profound concern for humanity has inspired us and many others to think about the world's long term problems".
46 Paul Ehrlich, The Population Bomb (New York: Ballantine Books, 1968). The book was also written with his spouse, Anne Ehrlich, who was not originally credited.
48 Rachel Carlson's Silent Spring (New York: Houghton Mifflin, 1962) was fundamentally different than other, broader, alarmist, environmental manifestos. Albeit received its own share of criticism and share of opposition, Silent Spring focused specifically on 'point sources' of pollution, and intrinsically targeted the use of hazardous pesticides such as DDT that, like other chemical synethetics, are persistent, difficult to breakdown biologically, and can accumulate across the biological food chain.
49 Hasan Özbekhan was a Turkish-American planner who worked for the System Development Corporation, one of the world's first software companies, a spin-off from RAND, the military research think tank in Santa Monica, California.
50 Alexander Christakis was a physicist turned social scientist involved in technological forecasting research, interactive management, developing strong ties to systems engineer John N. Warfield from the Battlele-Columbus Laboratories.
51 Limits can also be seen as the incarnation of Aurelio Peccei's "Project 1969" that he explained in great detail in the last chapter of his book The Chasm Ahead (Toronto, Canada: Collier-Macmillan, 1969) "to explore how existing or new forecasting and planning techniques be employed to describe present situations and trends, calculate projections, draw alternative paths and solutions to reach these goals. and generally foster a greater rationality and objectivity in the decision-making process." (219- 220). Peccei's "Project 1969" later evolved the Club of Rome's "Project on the Predicament of Mankind".
52 Battelle Columbus Laboratories, or BCL, is now Battelle headquartered in Columbus, OH.
53 In the 1970s, Battelle initiated several projects on urban problems. With the arrival of systems scientists and interactive
management expert John Warfield, Battelle undertook the Large City Design Project with Alexander Christakis, former
member of the Club of Rome. According to a self-published chronology, Warfield "initiates The Large City Design Project at
Battelle to: (a) study behavior in a group of experts who are striving to collaborate on a very problematic situation, full
of complexity and (b) to see whether the experts can develop a plan to design a city for a million people as a way to establish
a benchmark against which troubled cities can be compared" in "Chronology related to a science of complexity, generic design
science and interactive management covering the period 1956 - 1998" by John N. Warfield.

"The Allocation of Energy Resources" was a concise and pointed article by John Warfield, published in 1973, in Brookings Papers on
Economic Activity 3 (1973), pp. 529-570. The article outlines limitations of the modeling system. One of the most
important critiques of the world systems model employed by the Club of Rome was William Nordhaus, who
published a concise and pointed article "The Allocation of Energy Resources", in Brookings Papers on
Economic Activity 3 (1973), pp. 529-570.

John Warfield, a colleague of Alexander Christakis, further developed the idea of problématique as both concept and tool.
Stemming from systems thinking, and his work on interactive management (IM), Warfield developed computational and
graphical methods for illustrating "root causes" and identifying "the problem itself". See "The Problematique: Evolution of an

For a retrospective account of the interrelationship research with the Club of Rome and funding from the Battelle's Academy for Advanced Problems in How People Harness Their Collective Wisdom And Power: To

Konstantinos Doxiadis was arguably the most successful practitioner to engage the "urban" as "problématique". He
capitalized greatly on the notion of urbanization as uncontrollable phenomenon, and a process in crisis. See "Planners: Oracles at Delos" TIME Magazine (August 08, 1969).

One of the most important critiques of the world systems model employed by the Club of Rome was William Nordhaus, who
a year later, in 1973, published a concise and pointed article "The Allocation of Energy Resources", in Brookings Papers on
Economic Activity 3 (1973), pp. 529-570.

Happiness; with an Inquiry Into Our Prospects Respecting the Future Removal or Mitigation of the Evils which It Occasions
(1826).

In 1974, geoscientist Marion Hubbert King testified before Congress: "I was in New York in the 30's. I had a box seat at the
depression. I can assure you it was a very educational experience. We shut the country down because of monetary reasons. We
had manpower and abundant raw materials. Yet we shut the country down. We're doing the same kind of thing now but with a
different material outlook. We are not in the position we were in 1929–30 with regard to the future. Then the physical system
was ready to roll. This time it's not. We are in a crisis in the evolution of human society. It's unique to both human and geologic
history. It has never happened before and it can't possibly happen again. You can only use oil once. You can only use metals
once. Soon all the oil is going to be burned and all the metals mined and scattered." See Testimony before Subcommittee on
the Environment of the Committee on Interior and Insular Affairs, House of Representatives, Ninety-Third Congress, Serial no.


Gro Harlem Brundtland, Development and International Economic Co-Operation: Environment - Note by the Secretary

Meadows et al., The Limits to Growth, 7.

Club of Rome, The Predicament of Mankind, 14-16.

Hasan Özbekhan, "Toward A General Theory of Planning" Management and Behavioral Science Center (University of
Pennsylvania, 1969)


See the chaper on "The Emergence of "One World"" in Aurelio Peccei's The Chasm Ahead (Toronto: Macmillan, 1969): 135-
157.


See F. Gregory Hayden, "The Inadequacy of Forrester System Dynamics Computer Programs for Institutional Principles of
Hierarchy, Feedback, and Openness" CB4 Faculty Publications Paper 14 (2006).


For a pre-assessment of the challenges of population and resources, see "The Challenge of Man's Future" a book published by
Harriason Brown, with a chapter reproduced in Engineering & Science Vol.17 No.6 (1954): 22-32.


The notion that planning represents a general, unified, and collective practice is flawed. For a longer discussion and critique

Although it is portrayed as "a simplification of reality", the complexity of the World3 computer model and the feedback loops
and non-linear relationships it outlines, "does not distinguish among different geographic parts of the world, nor does it
represent separately the rich and the poor." Several other limitations of the modeling system are outlined in Limits to Growth,
the 30-Year Update: A Synopsis by the original authors of Limits (White River Junction, VT: Chelsea Green, 2004): 7.

"In "Dilemmas in General Theory of Planning", Horst Rittel & Melvin Webber write that "the formulation of a wicked problem
is the problem! The process of formulating the problem and of conceiving a solution (or re-solution) are identical, since every
specification of the problem is a specification of the direction in which a treatment is considered" (161) They further go on to
attack the linear method of operations research: "systems-approach of the military and the space programs is based on the
assumption that a planning project can be organized into distinct phases. Every textbook of systems engineering starts with an
enumeration of these phases: "understand the problems or the mission," "gather information," "analyze information,"
"synthesize information and wait for the creative leap," "work out solution," or the like. For wicked problems, however, this
type of scheme does not work. One cannot understand the problem without knowing about its context; one cannot meaningfully
search for information without the orientation of a solution concept; one cannot first understand, then solve. The systems-
approach "of the first generation" is inadequate for dealing with wicked-problems. Approaches of the "second generation"
should be based on a model of planning as an argumentative process in the course of which an image of the problem and of the
solution emerges gradually, subjected to critical argument. The methods of Operations Research play a prominent role in the systems-approach of the first generation; they become operational, however, only after the most important decisions have already been made, i.e. after the problem has already been tamed." (162)

After the 1920s, cities in the US began to incorporate forming into self-governing legal entities, primarily for census
demographics and later for tax purposes.

Ironically, it was the concept of population explosion in the "Third World" that later became synonymous with the "World Problématique" in the 1980s, as the Brundtland Commission states in *Our Common Future* (UN Report, 1987), with the observation that "Demographic phenomena constitute the heart of the African Development problématique. This is the data that lead most analysts to project a continuing and deepening crisis in Africa. There is no doubt of the imperative and urgent need for a far reaching population policy to be adopted and vigorously implemented by African governments. One issue of relevance that requires further research is the use of the tax system as a means for controlling population growth and discouraging rural-urban migration. To slow down population growth, should families without children be given a tax incentive or tax break? Should a tax penalty be imposed for each child after a fixed number of children, considering that the tax system has not solved the population migration problem? (78)


Forrester received immediate tenure at the age of 38 at MIT where he was invited to become Consulting Professor at the Sloan School of Management, formerly called the School of Industrial Management.

*Conversation with Jay W. Forrester, February 14, 2010, Concord, Massachusetts.*


It is not insignificant that MIT did not have a Department of Geography, nor did Harvard University. Forrester was unaware of the work of urban planner Kevin Lynch at MIT, nor that of systems ecologist Howard T. Odum, nor sanitary engineer Abel Wolman who were extremely active with spatial urban complexities. Forrester had very little patience for social systems theorists, urban planners, and systems thinkers who did operationalize or apply their work from, and in the field.


McHale, *The Future of the Future*. 5. In the dedication page, McHale explains the premise of the book to avoid misperception of his futurist views and confusion with a form of intellectual elitism: "The future of the past is in the future, the future of the present us in the past, the future of the future is in the present."

Regionalization designates the process of identifying overlapping regions of landscape change through networks, fields, processes of urbanization. See "Regionalization" by Pierre Bélanger, in JOLA - Journal of Landscape Architecture (Fall 2010): 6-23.


Howard W. Odum & Harry Estill Moore, *American Regionalism: A Cultural-Historical Approach to National Integration* (New York: Henry Holt, 1938): 5. Important to note that the regionalism advocated by Howard W. Odum in the first half of the century was more akin to notions of dispersed and diffused patterns of urbanization, that Benton Mackaye qualified as "super-urbanization" and Jean Gottmann argued for through the lens of an "irregular, urban landscape", and that did not intrinsically rely on notions of the city. The views of these early- to mid-century urbanists are fundamentally different and largely in opposition to the more centric, virtuous, moralistic concepts of regionalism and pedestrianism proposed by canons of smart growth and new urbanism pushed by Peter Calthorpe, Andrés Duany, Elizabeth Plater-Zyberk and a generation of followers.

In a lesser known text on the "Pattern of the Metropolis" (*Ducadal 90-1*, 1961, 79-98), Kevin Lynch outlines how problematic the notion of form is and instead proposes the need for more research and understanding of urban spatial patterns and their morphologies.


Howard Odum & Harry Estill Moore, *American Regionalism: A Cultural-Historical Approach to National Integration* (New York: Henry Holt, 1938): 5. Important to note that the regionalism advocated by Howard W. Odum in the first half of the century was more akin to notions of dispersed and diffused patterns of urbanization, that Benton Mackaye qualified as "super-urbanization" and Jean Gottmann argued for through the lens of an "irregular, urban landscape", and that did not intrinsically rely on notions of the city. The views of these early- to mid-century urbanists are fundamentally different and largely in opposition to the more centric, virtuous, moralistic concepts of regionalism and pedestrianism proposed by canons of smart growth and new urbanism pushed by Peter Calthorpe, Andrés Duany, Elizabeth Plater-Zyberk and a generation of followers.


In *Sprawl: A Compact History* (Chicago, IL: University of Chicago Press,2006), Robert Bruegmann discusses at great length the inevitability of sprawl and how efforts to thwart it may be doomed.

We can recapitulate that the goal of ecology - as the greatest, overlooked concept of modernity - offers a path toward perpetual growth. Thus, infinity becomes a more apt substitute for the concept of sustainability; a spatial, systemic, and material paradigm by which universality, transparency, interconnectivity can be both expressed, implied, and translated.

This text borrows the format of a lecture given by R. Buckminster Fuller in 1969, titled 'Planetary Planning' given in New Delhi (India), for the Jawaharlal Nehru Memorial Fund.