Ecological Urban Design for Performance

By

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Submitted to OCAD University

In partial fulfillment of the requirement's

for the degree of

Master of Design

In

Strategic Foresight and Innovation

Toronto, Ontario, Canada, December 2016

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Abstract

The primary problem the research project addressed is the manner and extent to which urban design can be re-positioned as a performance-based practice that incorporates the uncertainty inherent in the future of cities by providing adaptive responses to it using foresight and scenario creation.

Two research methods were used to gather data and information, a literature review and an interview with an expert in environmental planning.

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"Thus, when traveling in the territory of Ersilia, you come upon the ruins of abandoned cities, without the walls which do not last, without the bones of the dead which the wind rolls away: spiderwebs of intricate relationships seeking a form."

Italo Calvino, Invisible Cities

Introduction

Cities are ecosystems within which information, energy and other flows are exchanged. Urban design is inextricably bound up with regional geography which includes interdependent systems of nature, energy, information and economics which together comprise a regional ecology. Urban design and urban planning have tended to be approaches to managing the landscape, structures and infrastructure as well as human relationships with and within cities and their regions primarily on the basis of form. The complex nature of cities is often underrepresented in planning and design processes.

The primary problem the research project will address is the manner and extent to which urban design can be understood and practiced as performance-based in contrast to the more commonly accepted form-based approach of many design guidelines and commonly produced master plans.

I will investigate how urban design can be re-positioned as a practice that seeks to influence the changing patterns of the city based on providing design and performance strategies for individuals and institutions.

Because complex systems involve uncertainty, there is a need to incorporate learning in addition to planning in the design of cities. Methods that provide opportunities for imagining the future and exploring possible adaptive responses to it may be of more value than current master planning methods. Creating scenarios provides just such an opportunity. This MRP will explore possibilities for using scenario creation as an urban design tool.

Because urban design is primarily concerned with form, urban design guidelines and city or community master plans almost exclusively address form. Successive iterations and versions of guidelines and master plans can become increasingly brittle. In the case of guidelines or regulations each revision is often super-imposed on a prior guideline. Each version creates more layers and the guidelines or regulations can in some cases become contradictory. This results in planning and design processes that rely more and more on specialists and consequently are less and less transparent to the general public.

An alternative approach that is based in process may provide attractive alternatives. If some of the key drivers of urban form can be identified and understood then it may be possible to address those processes in the design approach. This could result in urban design methods that are both adaptive and transparent.

This implies the necessity to identify and affect the drivers of change rather than only the form of change. There will be many drivers of change in urban form, ranging from economic to environmental, energy sources to social factors.

Much current urban planning provides little room for adaptation or innovation and gives the complex nature of cities little consideration. An alternate approach that incorporated both top-down and bottom-up perspectives might provide greater latitude for incorporating the uncertainty inherent in the future of cities and technological innovations that will arise.

This Research Project will address four key research questions.

1. How might we re-position urban design to focus on the performance of cities?
2. What is the manner and extent to which recent urban design practices, including master planning and environmental assessment are based in process compared to form?
3. How might urban design address uncertainty?
4. What are some of the drivers of change in urban form?

Methodology

Two research methods were used to gather data and information, a literature review and an interview with an expert in environmental planning.

The interview was undertaken in order to gather background information and opinion on the environmental assessment process. It was anticipated that an interview would provide an efficient way to gain a broad perspective on the current practice of EA. It

would also provide direct information about a professional practitioner's experience and insights regarding selected aspects of the Ontario EA process that would not otherwise be readily accessible.

Interviews were planned with up to three professionals known to the interviewer, but the process proved more time consuming than anticipated. Much more time was required for transcribing the interview than anticipated and the decision was made that the time constraints of the term offset the benefits of multiple interviews. One interview did provide a good overview of the EA process while respecting the practitioner's professional considerations.

The literature review was intended to provide a review of existing and historical methods within a very selective range in order to provide context for the research questions and a base line against which to review conclusions. The material reviewed was analogous to a drill core sample; those methods are representative of a very specific geography and to a limited historical depth.

In addition to a review of methods, the literature included critiques of those methods which provided insights into strengths and weaknesses of the methods for purposes of evaluating possible innovations and alternatives to those methods. It provided a way to understand the history, development and context of the strengths, weakness and problems inherent in current and recent urban design practices in some regions of Canada and the United States.

Cities are Complex Systems

Cities are not simply an aggregation of form, they are ecosystems within which information, energy, nutrients and wealth are exchanged. Cities are complex, organic and contingent on a set of historically rooted forms and behaviors and are evolving systems where individuals, institutions and other agents constantly interact within the context of an environment. The form and urban patterns of a city are influenced by the behaviors of individual agents and institutions and those behaviors are in turn affected by the form of the city. Human economies and culture are immersed in natural systems, urban and peri-urban ecosystems include humans, we are not passive bystanders in the relationships that ecosystems are expressive of. This recursive loop of behaviors influencing forms and the patterns themselves influencing adaptive changes in behaviors is evidence of complexity. This description of the city, in addition to being fundamentally different than the form-based descriptions that we've grown used to, bears resemblance to many other complex systems that are the subject of study in the emerging science of complexity.

In Jane Jacobs seminal book, The Death and Life of Great American Cities, she clearly articulated the opportunity to view and understand cities in the light of complexity theory (Jacobs 1961: 429). Jacob's contends that cities belong in the same category as the kinds of problems that Warren Weaver called "organized complexity" (Weaver: 1958). What Weaver referred to as "factors" in the realm of biology, were in the case of cities, individuals and institutions, each acting according to their own aspirations and rules. These actions inform the relationships within the system (Mitchel 2009).

Because complex systems involve uncertainty, there is a need to incorporate learning in addition to planning in the design of cities. Learning is a key component of the design process that differentiates it from the rational planning process and is a bottom-up aspect that is be integrated into design and makes it a similar process to ecosystem adaptive management.

Another characteristic of complex systems is that they exchange information, both internally and across system boundaries. Melanie Mitchell defines a complex system as, "a system in which large networks of components with no central control and simple rules of operation give rise to complex collective behavior, sophisticated information processing, and adaptation via learning revolution" (Mitchell 2009:13). She notes that her use of the term complex system implies complex adaptive system. Complex systems tend to incorporate a larger quantity of interrelated information than is normally involved in what Jane Jacobs called simple problems or problems of disorganized complexity. These types of systems process vast amounts of information and in doing so consume significant amounts of energy.

This relationship between information and energy is key to understanding the evolution of cities. Cities confer a benefit on their inhabitants, the ability to process information more efficiently than other spatial configurations. This relationship between information and energy is paralleled in a direct manner by one between economies and energy. Starting in the 1930's Georgescu-Roegen explored this relationship between energy and economy and proposed that economies are complex adaptive systems (Gowdy and Mesner, 1998) and that for this reason classical and neoclassical economic theories do

not provide effective models for understanding economies or developing economic policy in the modern world (Georgescu-Roegen 1986). Much current urban planning is rooted in the rational method and like the neoclassical economic theories critiqued by Georgescu-Roegen; it gives the complex nature of cities little acknowledgment.

Urban design involves a large number of related variables in nested or interconnected domains, including those of information, energy, wealth and labour. The domains and variables are united by processes of exchange. Concepts rooted in ecology and economics that enquire about rates of change and the flow of information, energy and nutrients may provide an effective lens through which to understand the behaviors and spatial forms that occur in our increasingly urban world and the concerns and issues that have come to dominate urban design. It seems possible that the relationships and increased efficiency of information exchange, economic exchange and energy consumption in large part account for the emergence of urban agglomerations and their performance in terms of creativity, ideas and the accumulation of wealth. (Bettencourt 2013, Hall & Pain 2006, Georgescu-Roegen 1986, Homer Dixon, Beinhocker 2006)

Marshall McLuhan noted that all change can be understood in terms of pattern, rate or speed, or size (McLuhan, 1994). Design is concerned with affecting change and the rate of change is a variable that merits consideration in urban design. It is a factor that has a significant impact on the uncertainty inherent in complex systems. The significant differences in rates of change in the media of built form and traditional infrastructure as compared to communications infrastructure has a significant impact on the rates of exchange for the currencies of both ideas and of traditional economic instruments.

It is Jacob's contention that past practitioners of urban design did not recognize the kind of problem they were dealing with and she provides two examples (Jacobs 1961:235). Ebenezer Howard was the originator of the Garden Cities model of Town Planning, and perhaps somewhat unfortunately finds himself in Jacob's sights as a practitioner who approached city design using the simple problem model. I say unfortunately but could perhaps equally claim unfairly. I say this because Jacobs herself mentions the fact that cities are more complex than smaller urban entities. If her use of Ebenezer Howard as an example of someone who misunderstood the type of problem he was dealing with is unfair, it's because Howard likely saw himself as a town planner. On the other hand, we do refer to his work as the Garden Cities movement not the Garden Town movement.

The second example Jacob uses is Corbusier and his plans for the Radiant City. Corbusier was the foremost proponent of the early modernist interest in architecture's ability to design "machines for living". In his plans for the Radiant City he attempted to expand this quest from the traditional architectural scale of buildings to the scale of cities. He proposed as a series of highrise and mid-rise architectural residential towers that would both make for more efficient and therefore machine-like social arrangements but also, in a move that can be readily understood as anathema to Jacob's, proposed the street be incorporated into the buildings and largely banished from the exterior public realm in favour of green space. It might be argued, that in fact, Corbusier's idea was to subsume the city within architectural form and practice. In many ways, we are still saddled with the legacy of this. Jacob's sees this as an instance of applying methods more appropriate to a problem of disorganized complexity than to a problem where the variables are

interconnected and cannot be approached from the perspective of rational reductionism.

As an alternative, she suggests that analytic methods similar to those employed in the life sciences are more appropriate for the design and planning of cities. In this she takes Weaver's suggestion to, "extend these new techniques, if only by helpful analogy, into vast areas of the behavioral and social sciences." (Jacobs 1961:433).

Weaver demonstrated that the life sciences consistently address problems of organized complexity and that problems can be categorized into three different types. They are either problems of simplicity, problems of disorganized complexity or problems of organized complexity. (Weaver 1958) and goes on to explain that: problems of simplicity are those that consist of two variables, problems of disorganized complexity consist of more variables where the variables are not interconnected. The third type of problem, those of organized complexity, consist of more variables and the variables have a "sizable number of factors which are interrelated into an organic whole" (Weaver 1958, Jacobs 1961).

In complex systems, the relationship between the various individuals and the various institutions give rise to collective behaviors that are unpredictable. In large part this is due to the sheer number of factors and agents but it is also attributable to the fact that in the case of individual human and urban institutions, their values and goals are not necessarily shared. In the case of problems of natural science, nature of course has no predetermined vision. Variety seems to be the "object" of the evolutionary process.

In fact, variety and change are also components of all complex adaptive systems. As Mitchell notes, “systems adapt- that is, change their behavior to improve their chances of survival and are successful through learning or evolutionary process's (Mitchell 2019: 13)

Note however, that Jacob’s does not mean by analytic methods, “rational planning”. In fact, she is scathing in denouncing this. When she talks of rational planning, she means city planning based on ratios and statistics, which consider the city either a simple problem or one of disorganized complexity. She provides a good example of each of these failures in approach. The first is in her description of how to approach the design of neighborhood park. She advocates that the designers pay attention to the uses of the park and of the adjacent neighborhood, and that recognition be given to the fact that these uses change in both spatial and temporal dimensions of that use.

Jane Jacobs specifically advocates that urban designers look for “intricately interconnected, and surely understandable, relationships.” (Jacobs 1961: 439) and suggests the following three broad methods:

1. think about process
2. work inductively - from particular to general
3. look for clues in small quantities that reveal larger and more average operating quantities

In addition to these three methods Jacob’s recommends, she also suggests two key approaches to urban design that may appear so obvious as to be overlooked. She points out that, “in the life sciences, organized complexity is handled by identifying a specific

factor quantity - say an enzyme- and then painstakingly learning its intricate relationships and interconnections with other factors or quantities. All this is observed in terms of the behavior (not mere presence) of other specific (not generalized) factors or quantities." (Jacobs 1961: 440) While the notion of looking for specific behaviors is critical and undoubtedly one of her most important contributions in helping designers and others think of cities using this lens that is central to the study of ecology, I suggest that her use of the two action verbs, learn and observe, provides insight into the key difference between design and planning practices. Design is both bottom up and top down, and in being so it provides an opportunity for learning as part of the process. Observation is part of this learning process.

The fact that many variables need to be taken into account, is evidence that this kind of urban design problem, "is a far cry from the simple problem of ratios of open space to ratios of population." (Jacobs 1961: 433). In a similar way she dismisses planning that approaches cities as problems of disorganized complexity. In her view, "statistics … tell almost nothing about how the quantities are working in systems of organized complexity." (Jacobs 1961: 442) However it is not clear how she differentiates a situation where the variables are not interconnected, that is a problem of disorganized complexity, from situations where the variables are connected. This is an especially knotty problem, given there is a sense in which we now recognize everything is connected. This also seems to be in direct opposition to Luis Bettencourt's approach to understanding urban complexity, one that is driven by big data and the compilation of statistics in systems that he specifically recognizes are complex (Bettencourt 2013). Part

of this apparent contradiction may simply be that Bettencourt does not identify the work he is doing as design, although clearly he is proposing an approach to urban planning. If in fact cities have characteristics that are identifiable over time and space, in other words, universal characteristics, as Bettencourt claims (Bettencourt 2013:5), two important questions arise. Are these characteristics emergent and given the unpredictable nature of complex systems can we plan or design for these characteristics or to encourage their emergence or support them when they appear? I believe the answer to both of these questions is yes and that foresighting techniques and scenario methods provide possible approaches to design with and in complex adaptive problem sets such as those presented by cities.

Overview of Selected Existing Environmental and Land Use Design and Planning Approaches: Master Planning, Environmental Assessment, Adaptive Management

This chapter consists of a review of selected environmental design and planning approaches and some specific master planning, environmental assessment and adaptive management methods. A brief background review is provided of approaches taken in North America and the United Kingdom since the beginning of the twentieth century. This is followed by a review of the specific master planning approach developed by Ian McHarg and described in his landmark book, Design with Nature (McHarg 1969). The next section of this chapter is devoted to an overview of environmental assessment at the Canadian Federal level and in Ontario and the final section provides an introduction to adaptive management.

Master Planning

Scale is a question that bedevils urban design.

Part of the reason for this is due to a discrepancy in the needs for centralized control and order in many of the infrastructure projects that are components of cities and the benefits of bottom-up input to many components of neighbourhoods, such as parks and local streets.

Large scale projects such as the highways and regional roads, train and subway routes, and centralized power distribution networks that interlace cities are rooted in efficiencies of scale that are tied to underlying economic and social assumptions.

Infrastructure projects such as these, are modalities of exchange between cities, regions and increasingly nations that reflect the transition of production, distribution and consumption from intra-local to inter-global that has occurred in parallel with the transition to industrial scale generation and distribution of power, food and information. Many of the socio-economic assumptions that are baked into these projects, concern control of energy and information flows and all of the assumptions concern wealth and its distribution. They are the formal expressions of the reality that design is political. This is the underlying reason that design, expressly urban design, must be participatory.

While Lewis Mumford and Jane Jacobs disagreed on some issues related to scale and order, they both emphasized the importance of public participation in urban design and in large part this was because they both recognized the interwoven complexity of the ecological, social and economic aspects of cities (Mumford 1961, Jacobs 1961).

Predating Jacobs and Mumford in their criticisms of and advice on, urban planning urban design in North America, were several key figures in the United Kingdom. These included, John Burns, Ebenezer Howard and Patrick Geddes (Howard 1898, Hughes 1971, Spirn 1984, 2012, Stalley 1972, Sennett 1905), all of whom had direct connection to the Garden Cities movement which emerged in Britain at the turn of the 20th century. While influential in the evolution of urban planning and design, or 'civics', as Geddes referred to much of his work (Chabard 2009), the considerations of these men were primarily issues of employment and housing rather than environmental.

The Garden City movement can be linked with the Reformers and Fabians of the late 19th century, but the theory did not originate from these quarters. Lewis Mumford and

Frederick Osborne, American and British advocates of and spokesmen for the Garden City movement among other things, acknowledge the influence of George Bernard Shaw had H.G. Wells, but also declare that ultimately they were disenchanted with these two men (Hughes 1971: 61, 170-174). Wells and Shaw were both members of the Fabian Society but perhaps more important although less acknowledged, is the fact that Wells was also a member of a small and influential group of intellectuals that belonged to the Sociological Society, founded by Patrick Geddes and H.G. Wells in 1903. This group was heavily influenced by LePlay's ideas (Stalley 1972) and saw both regional studies and linking the study of people to their place and work as essential to the study of cities. "Place," "Work" "Folk," were of equal if not more importance then "Environment, Function [and] Organism." (Stalley 1973:10)

This idea was expressed by Geddes as, “a city is more than a place in space, it is a drama in time… just as place, occupation and family are intimately connected in the practical world, so their respective cultural institutions must be more and more viewed as a whole…” (Stalley 1972:43-44)

Directly inspired by Ebenezer Howard's 1902 text, *Garden Cities of Tomorrow*, (originally published in 1898 as, Tomorrow: a Peaceful Path to Reform), the Garden Cities were an attempt to harness the geopolitical power of urban form to the perceived political needs of their citizens. Garden Cities were set up as companies and every citizen in a Garden City, was a shareholder of the Company. The stated intent of these companies was to make the citizens more geopolitically independent from central government so that, “with greater freedom from the control of the Central Government, it may be found -

especially on municipally owned land - that the field of municipal activity may grow so as to embrace a very large area, and yet the municipality claim no rigid monopoly and the fullest rights of combination exist." (Howard 1960:90) In effect, the Garden Cities were what came to be understood as, local states (Cockburn 1977). This geopolitical power was given expression through the 1909 town planning legislation (The John Burns Act) and the British Labour government's, Town and Country Planning Act (1947), both of which were directly influenced by Howard's work.

It is important to recognize that Howard was a social reformer and theorist first and his interest in form was secondary. His designs were a reflection of his social thought and rooted in process. Mumford, in the introduction to the 1960 edition of *Garden Cities of Tomorrow* says of Howard, that he was, "little concerned with the outward form of the new city… he was concerned with the processes that would produce such communities (Howard 1960:37)

This emphasis on the impacts of urban design on employment, housing and capital, shifted significantly in the 1960s. While there were some criticisms of specific environmental implications that were consequences of the form of the Garden Cities (Sennett 1905), these were tied to very specific human health outcomes. For instance, Sennett claimed that the circular form of the Garden Cities road network could diminish the public health benefits of smog clearing breezes that a city using the grid might produce.

Although Jacobs, Mumford and McHarg were all influenced by the thinking of Geddes and Howard, in Death and Life of Great American Cities (1964), Jacobs directly linked the

civic and social aspects of LePlay and Geddes, (Place, Work, Folk) to the biological (Environment, Function, Organism) in a way that recognized cities as complex adaptive systems. In doing so, she opened the door wide to a method that would incorporate ecology into urban design and three years later Ian McHarg walked through that door with the publication of *An Ecological Method for Landscape Architecture* (McHarg 1967). In the introduction written for the book, Lewis Mumford asserts that," on its intrinsic merits I would put it on the same shelf that contains as yet only a handful of works in a similar vein, beginning with Hippocrates, and including such essential classics as those of Henry Thoreau, George Perkins Marsh, Patrick Geddes, Carl Sauer, Brenton McKay and Rachel Carson" (McHarg 1971).

McHarg sought to provide a method that united natural science and design, "a method which has the power to reveal nature as process, containing intrinsic form" (McHarg 1967: 105). Early in his seminal book McHarg states, "let us accept the proposition that nature is process…" (McHarg 1971:7).

To make sure that there is no misunderstanding as to how form relates to process, he makes the following statement on form, "Certainly we can dispose of the old canard, 'form follows function'. Form follows nothing -it is integral with all processes. Then form is indivisibly meaningful form, but it can reveal ill fit, unfit, fit and most fitting." (McHarg 1971:173). "form and process are indivisible aspects of a single phenomenon. The ecological method allows one to understand form as an explicit point in evolutionary process." (McHarg 1967: 107)

The method he developed is still the basis for many landscape architectural and urban design projects and one that incorporates many of the key steps that are addressed in both environmental assessment (EA) processes and adaptive management (AM) processes. Data gathering and analysis are aspects of his ecological method of master planning that are common to both EA and AM; in addition AM also shares intervention, adaptation and participation. However, neither the EA and AM methods are understood as design methods per se, rather they both call out a step within their method as "design".

In the data gathering phase, McHarg prescribes an ecological inventory be made that includes: water (hydrology), soils, physiography, climatic data and plant communities. In addition an inventory of cultural or social attributes is collected, including physical disease, mental disease, social disease, income, population density, age and ethnicity.

After the inventories have been collected they are mapped. This is done by creating layers representing each of the natural and cultural components or factors and then overlays of these are composed in order to make visualize the data as composite maps. These maps help to reveal the form of unique sites and various components: minerals, water resources, slope and solar exposure , agricultural suitability, forests and plant communities, recreational opportunities, geological suitability for urban structures and the like. In this way, the maps turn the data into information and permit an understanding of the specifics of the place.

Once the maps have been created, the designer can develop a comparative matrix of land uses (See figure 2-1). In the matrix, the factors are identified and ranked on a

gradient from 1 to 5. It's important to note, as McHarg does, that there are, "technical problems (are) inherent in the method. The first of these is ensurance of parity of factors." (McHarg 1971:115) This is an important consideration, because this is where public participation in an urban design process allows for input into the evaluation of the factors and their weighting. McHarg explicitly talks about the benefit of stakeholder input in the process and each community establishing their own value judgements, "in addition to being rational, the method is explicit…. This is in direct contrast to the bulk of planning, were the criteria are often obscure and covert….. The community can employ its own value system…. Today many planning processes, notably Highway planning, are unable to incorporate the value system of the community to be transected. At best the planner supplies his own distant judgment." (McHarg 1971:105) It will become apparent when environmental assessment processes are discussed later in this paper that the situation with regard to highway planning and other infrastructure planning still remains as McHarg described it fifty years ago.

However, he doesn't spend much time to describe the mechanisms for that participation. An aspect of McHarg's method which clouds the issue of values, is that central to it is his belief that the natural and cultural imprints of history on any given place provide an identity and reveal what he calls "social values".

"The basic proposition employed is that any place is the sum of historical, physical and biological processes, that these are dynamic, that they constitute social values, that each area has an intrinsic suitability for certain land uses and finally, that certain areas lend themselves to multiple coexisting land uses." (McHarg 1971:104)

One immediately notes the inclusion of the term value in this sentence. What he means by this becomes more apparent as he elaborates on the method more fully; it becomes apparent that he is merging the idea of fitness into design. While the suitability analysis and mapping method is a recognized legacy of his work, this explicit linking of natural and cultural factors of place to values and fitness may be the most significant if subtle aspect of his thought.

How does one evaluate the city or regions natural and cultural attributes of identity, what McHarg calls social values?

"*A recognition of these social values, inherent in natural processes, must precede prescription for the utilization of natural resources. Once it has been accepted that the place is a sum of natural processes and that these processes constitute social values, inferences can be drawn regarding utilization to ensure optimum use and enhancement of social values. This is its intrinsic suitability… The social values represented by the natural processes more often than not are inherently suitable for a multiplicity of human uses."* (McHarg 1971:104)

In order to interpret the data, he shows that it is necessary to provide criteria and over the course of *Design with Nature* proposes linking health to the natural and cultural factors. Fitness is gradually revealed as the primary goal of ecological design

He suggest that we, "Select health as a criteria over "economic determinism' to preserve and enhance the identity that has evolved from natural and cultural processes (McHarg 1967:107) and provides a comparative matrix of health and ill-health (italics below): derived from McHarg 1967)

Ill-health	*Health*
Simplicity	*Complexity*

Uniformity	*Diversity*
Independence	*Interdependence (symbiosis)*
Instability	*Stability (steady state)*
Low number of species	*High number of species*
High entropy	*Low entropy*

Information

McHarg imagined a people who he called the Naturalists, and suggested that, “the world is, for the Naturalists, a great voice of ‘to whom it may concern’ messages, clothed in form. Form then is communication, the presentation of meaning.” (McHarg 1971:168-9) In this light, form expresses the significance of the relationships of people with their local environment and of people with people. Communities can be understood as an articulation of the meaning and value of these relationships and a form of sense-making about the relationships. The relationship and form of the community are subject to constant interpretation.

Environmental Assessment

This section of the paper provides background on and context of environmental assessment in Ontario, by providing a review of the Canadian Environmental Assessment Act (CEAA) and the Ontario Environmental Assessment Act the (EA) Act. The purpose of these two pieces of legislation is summed up as follows:

"Generally speaking, the primary objective of an EA under CEAA is to determine whether a project is likely to result in significant adverse environmental effects…" (Olszynski 2010:6).

The objective of the Ontario Environmental Assessment Act (EA) Act is, the, "betterment of the people of Ontario by providing for the protection, conservation and wise management of the environment." (EA) Act

As has been discussed, concerns about the environment came to the fore during the 1960s in the writings of Jane Jacobs, Rachel Carson, Ian McHarg and numerous others. At that time, in both Canada and the US, government policies or legislation that might address these concerns, were not perceived to be integrated pieces of economic policy. The role of the state in ensuring economic development and prosperity certainly extended to social aspects of fiscal policy through legislation addressing relationships between trade unions, corporations and private enterprise, but generally speaking these policies and institutions were not understood as being connected to or nested within an environmental realm. However, as pollution and the impact on public health of chemicals like 2-4D, produced by Dow, DuPont and other significant corporations that

grew out of the military-industrial complex in the 1950s, became recognized as threats to both health and political stability, first the US and then Canadian governments at the federal and provincial levels enacted legislation aimed at addressing the emerging environmental movement and the concerns articulated by it.

Environmental assessment processes are codified in Canadian federal legislation, the *Canadian Environmental Assessment Act* (CEAA) and Ontario provincial legislation, the *Environmental Assessment Act* (EA) ACT. CEAA has its roots in the 1973 Federal Environmental Assessment Review Process Guidelines. Two years later Ontario adopted the Environmental Assessment Act. Both of these pieces of legislation were predated by a requirement for environmental assessments to be performed by US federal agencies as a result of the 1969 National Environmental Policy Act (NEPA).

CEAA and the EA Act were anticipated to provide policy and decision makers with a means to identify and mitigate issues associated with major projects that were drivers of both economic prosperity and had important environmental considerations. In addition to recognizing that decisions about large scale infrastructure had an economic impact, there was a growing recognition that the environmental aspects needed to be addressed as well, both for the noted reasons of public health but also to provide stability to government or at least to the ruling political party. This latter objective especially, meant that the incorporation of a process that enabled public input was an important consideration of the legislation.

These environmental concerns, while not strictly limited to pollution, often involved air, water and land quality. The Mackenzie Valley Pipeline Inquiry (1974), often known as

the Berger Inquiry, after its lead author Thomas Berger, was the direct outcome of the 1973 Canadian federal guidelines. At a provincial level, the government of Ontario was caught up in political controversy over Ontario Hydro's plans to construct large scale transmission networks throughout rural Ontario without a public consultation process associated specifically with the projects. The resulting conflict and public protests were directly aimed at the government of William Davis (Winfield 2016). It was hoped that the EA Act would provide a mechanism for generating trust and a sense of inclusiveness in the system, or in a more cynical view, would at least deflect or absorb negative public sentiment towards the government

Twenty years after the passing of the EA Act, Ontario enacted the *Environmental Bill of Rights* (EBR) 1993 and in 1999 the federal government passed the *Canadian Environmental Protection Act*, both of which made significant provision for public participation.

However in 1996 the Ontario government made significant changes to the EA Act. It streamlined many procedures and, perhaps most alarmingly, eliminated proponents' requirement to fully take into consideration the need for the project in the first place. As a direct result of these changes, a decade later there is significant dissatisfaction by many parties with the EA process. This culminated in a scathing indictment by Ontario's Environmental Commissioner in his 2007-2008 Report that stated,

"environmental assessment has a crucial role to play in our lives; it should be society's preeminent tool to carry out farsighted planning for public infrastructure in the name of public good. Unfortunately, Ontario has been long burdened with an EA system where the hard questions are not being asked, and the most important decisions aren't being made - or at least not being made in a transparent, integrated way. The province has

increasingly stepped away from some key EA decision-making responsibilities, and the Ministry of the Environment (MOE) is not adequately meeting is vital procedural oversight role. As a result, the EA process retains little credibility with those members of the public who have had to tangle with its complexity." (Lindgren & Dunn, page 8)

The process

Generally speaking an EA is required for public sector projects and not private sector undertakings. There are two types of provincial EA in Ontario, Individual EA's and Class EA's.

Individual EA's require project specific terms of reference (TOR) and the results must be submitted to the Minister of the Environment for approval.

Class EA's cover a wider range of projects that are generally similar in nature and are understood to have predictable environmental effects. This assumes of course that either the environment is not a complex adaptive system or that the effects of the projects are predictable. Class EA projects are preapproved by their inclusion under a parent class EA, of which there are ten. If the proponent follows the appropriate process then the project meets the requirements of the Act. How this can be considered a process of assessment is, understandably, unclear to most members of the public. Class EAs in and of themselves are subject to the following fundamental criticism.

"In 2008, Ontario's Environmental Commissioner summarized public concerns about class EAs is as follows: 'Class EA approaches were intended for projects that occur frequently, but generally predictable ranges of effects and relatively minor environmental impacts. But critics have long argued that too many large and environmentally significant projects have been inappropriately slipped into the class EA fast-track… Under the class EA process, public concerns abound. A "no" decision is not a possible outcome, the ministry can only elevate the status of the project to an individual EA or impose conditions. Frustrated members of the public invoke the available appeal mechanism (a request for a "bump up" to an individual EA, also known a "Part II order")

about 60 to 70 times in a typical year, but to the ECO's knowledge, the ministry has not granted one such request." Lindgren & Dunn 2010:296)

Within the Municipal Class EA's there are three broad schedules, A, B and C. The first of these applies to general operations and maintenance projects. The second includes minor expansions and improvements to existing infrastructure. Schedules A and B only require Phases One and Two of the EA process to be undertaken. Schedule C projects, such as the major expansion or new construction of infrastructure, require Phases One through Four of the process be undertaken. All three schedules require public consultation to various extents.

In all cases, a series of inventories are collected and mapped, in many ways reflecting the processes described by Ian McHarg (McHarg 1969). Typically these inventories and maps include geology, soils, vegetation, wildlife habitats such as wetlands, aquatic habitats, woodlands, meadow and grasslands, various types of regulated areas and species project risk (SAR). In addition a summary review of provincial, regional and municipal planning policies, documents and undertakings including pertinent master plans is undertaken and provided in report format. A summary review of socio-economic land-use data is also provided.

At this point, what is generally understood as the design component of an EA is inserted into the process. A design concept, or what is referred to as a solution is proposed in parallel with one or more alternate solutions. One of the alternatives is always the "do nothing' alternative, but if the result of the master plan or policy decision that triggered the EA had been to do nothing, then there would never be an EA, so the do nothing alternative is a fiction. It is effectively outside of the scope of the EA as it would not

meet the objectives confirmed in the master plan. In fact, this Catch-22 is embedded in both the class EA's and individual EA processes. In addition to this individual flaw in the EA process, the linear and sequential process of Master Plan and EA is a central weakness of the planning and engineering methodologies that it is based in. It is not a design approach, and the design aspect of EA's is not strategic. In addition to this methodological weakness, the Master Plan components that precede the EA component of the process themselves tend to be siloed infrastructure master plans. Their focus can often be on the engineering aspects of infrastructure and the socio-economic drivers of the master plan are political strategies with inadequate account being given to them in the assessment process. This political aspect and the determination of need is not adequately captured in participatory aspects of either the master plan or EA process. In fact, these political considerations of need can be deemed out of scope of either the Master Plan or the EA. While divorcing the assessment of need from an engineering assessment or even a planning methodology may be acceptable, it is not a defensible design process. Urban design master plans are most often done at a neighbourhood scale and are often merely a mash-up of infrastructure plans rooted in transportation master plans with pretty illustrations of neighbourhood form that pass for plans. The infrastructure master plans themselves are, at best, rooted in population growth projections and analysis versus a City scale vision of culture and economics nested within environment and equivalent in power to an Official Plan. This recognition of an urban ecology rooted in a particular place and time would provide the basis for the expression of identity unique to each city. It is this disconnect in the scale of neighbourhood "design" and regional infrastructure design that is a fundamental

challenge when discussing urban design. The population and growth strategies, for instance, of the 2005 Places to Grow Act in Ontario are only now, in late 2016, being linked to environmental strategies and plans. For instance, an advisory committee to the Ontario government chaired by David Crombie is currently finalizing the report: Planning for Health, Prosperity and Growth in the Greater Golder Horseshoe 2015-2041. Public comments closed on this report in October of 2016 and the final outcome remains to be seen. It is encouraging however, that the report recognizes the need to take into consideration four significant provincial plans; the Growth Plan for the Greater Golden Horseshoe, the Greenbelt Plan, the Niagara Escarpment Plan and the Oak Ridges Moraine Plan. The committee notes that, “We view climate change as a critical driver for many of the policies in the four plans, one that needs to be brought into the mainstream of all our planning and development activities.” (Planning for Health, Prosperity and Growth in the Greater Golder Horseshoe 2015-2041). It makes a number of recommendations that appear to incorporate the following from the province’s Climate Change Action Plan 2016-2020. These include the following

- Promoting stronger protection and enhancement of natural systems and agricultural lands
- Directing upper- and single-tier municipalities to prepare climate change plans or incorporate policies into official plans to advance climate change mitigation and adaptation goals
- Requiring greater integration of infrastructure planning with land use planning

- Requiring integrated watershed and sub-watershed planning as a prerequisite for settlement area expansion, and major new developments and infrastructure projects
- Promoting the identification, mapping and protection of an agricultural system throughout the region
- Implementing stronger criteria to limit the loss and fragmentation of prime agricultural lands, particularly in the outer-ring municipalities beyond the Greenbelt
- Supporting productive agriculture
- Recognizing the importance of locally sourced food and urban agriculture
- Integrating the needs of agriculture throughout the plans, for example when considering settlement area expansion, the rural economy, management of natural resources, infrastructure development, climate change and plan implementation
- Applying an agriculture lens to other provincial policies and programs (such as climate change, transportation and infrastructure, financial tools, community improvement plans and education) to address the unique needs of agriculture in the GGH

(Ontario Climate Change Action Plan 2016-2020)

While it is dismaying to see a requirement for municipalities to integrate climate change plans and strategies into their Official Plans and for greater integration of infrastructure planning with land use planning will only have a *start* date of 2017-2018, it is another

step in the right direction. A major weakness however is that there do not appear to be any targets associated with this provincial action plan, the Ontario Climate Change Strategy 2015 that preceded it, or the City of Toronto's Climate Change Action Plan 2007.

While there are targets in the Federal Sustainable Development Strategy for Canada 2016-2019, they are not strongly linked with provincial or municipal environmental systems design or planning.

Once an EA process is underway a number of criteria are developed to identify and assess the impacts of the project on the environment. Remember that included in environment, are the social and economic and so the total impact of a project is evaluated based on criteria and relative impacts of the various alternatives generated. This means that a project may take into account such things as connections, community impact, safety, ease of constructability, cost and natural environment. Each of these social, environmental and economic sub-categories are weighted and scored, but the black box of weighting scoring can mean that the impact of the project on habitat, groundwater, wetlands or other components of natural environment may account for a small percentage of the total "score". With this, the evaluation and selection of the "preferred alternative" is complete and all that remains is to list the effects of the "solution" and propose mitigation measures. There are requirements for permits and approvals prior to implementation of project, but these are not specifically subject to community comment or intervention.

Assessment of need

A major aspect of environmental assessment was intended to be an assessment of the need for the project. In 2011, Bill C-38 repealed the existing federal act and it was replaced with the Canadian Environment Assessment Act, 2012. When that happened,

"Considerations of the need and rationale for projects, their overall environmental impacts, cumulative effects (except in very limited terms), social and economic consequences (except narrowly in relation to aboriginal peoples) and the availability of alternatives, were eliminated from the process. The legislation also permitted the "substitution" of provincial assessment processes for federal reviews under CEEA." (Winfield, 2016, page 14)

Due to streamlining efforts in 1996 however, the evaluation of need had already been largely eliminated in Ontario and the focus of EA became mitigation (Winfield 2016, Lindgren & Dunn 2010). As a result, the assumption made for purposes of an EA today is that the assessment is restricted to the project and alternatives do not apply to what can be called the strategic need (Winfield 2016) for the project. What this means is that the opportunity need for the project is often based in a master plan that precedes the EA. It is critical to recognize however, that many if not most of the master plans that form the basis of the EA are discipline specific and tend to reside in their own silos. For instance they may be transportation master plans or cycling master plans. The hierarchy of disciplines within a given municipality or region determines from the outset the relationship and relative importance given to each category of infrastructure. For instance, the relationship of parks to roads when speaking of form or the relative importance of ecological connectivity and vehicular movement when speaking of process are determined prior to a master plan being undertaken for any particular one of those urban or regional components. Given the preponderance of engineers and the approach of their discipline in municipalities, transportation master plans will often

trump parks or open space master plans and there is little evidence of what might be understood of as an ecosystem master plan. Ecosystems as an infrastructure type, what can be considered “landscape infrastructure” (Waldheim xxx) tend not to be designed by engineers and in fact, there are no departments of ecosystem in most municipalities. There may be a parks department or a forestry department, there will certainly be a works department but as surprising as it may seem, the closest that we have to an ecology or environment department in most cities might well be urban design. In my experience the mandate of most urban design departments and their leaders is merely to review the form on some kind of normative bases that results from land-use planning policies that are at best primarily rooted in population and growth assumptions and targets, not in what I would consider any kind of environmental design vision. In fact, in 2015, when I asked the head of urban design for the City of Toronto where the city's urban design vision was rooted, his response was the Official Plan (OCAD Urban Ecology Conference, Toronto, 2015). The Official Plan in Toronto at any rate, does not express a vision of urban ecology or environment. Whether this is a shortcoming of urban planning or urban design is a valid question. However, it is clearly a shortcoming of urban design if at the scale of a major city it aspires to merely implement the primary document of urban planning.

Opportunities

The Federal Sustainable Development Strategy for Canada 2016-2019 has eleven goals, but there is not a goal or target specifically integrated with provincial environmental systems design, municipal planning or urban design. One of the goals, the eleventh, Safe

and Healthy Communities, speaks directly to a very narrow set of outcomes for communities. However, like the environmental assessment legislation of the 1970's the targets associated with this goal are tied exclusively to pollution. Greenhouse gas targets are tied to the first goal and so there is a sense in which this could be a driver for and linked to a broader environmental approach at the urban level. The most accommodating explanation for this lack of integration may be reluctance by the federal government to be perceived as dictating to the provinces or the cities. However, given the increasing recognition over the past fifty years of the economic and political importance of environmental issues, this may not be an astute or effective policy decision. In any case, it appears to leave the responsibility for achieving integration of urban design and ecological or environmental objectives, with the provinces and municipalities.

Limitations and Concerns

While the purpose of the EA Act is "the betterment of the people of Ontario by providing for the protection, conservation and wise management of the environment" it frequently seems to be understood as a mechanism for selecting a design or method that best meets the needs of the project being assessed. While a given project might be interpreted as providing for the betterment of the people of Ontario, the fact is, the betterment is specifically to be achieved by providing for the protection, conservation and wise management of the environment. This cannot be distorted to mean, achieving the needs of the project by minimizing adverse environmental effects. In effect, the project represents the needs of the proponent and these needs are not necessarily the

same as the needs of the stakeholders. Is many ways, this sums-up the single greatest flaw in the EA process. The question of needs is not adequately addressed in an EA. The issue of needs is legitimately a political question and in the same way as the more tangible and visible conflict around projects has been ceded to the EA processes as a way of absorbing political discontent and conflict, the strategic question of needs is often beyond or at least separated from the EA process. In the best case, these strategic needs are left to be negotiated by proxy through the professional services of planners, engineers and others. These disciplines are often more used to addressing what Jacob's called "simple" problems and what Gell-Mann refers to as "simplicity" and they are historically ill equipped to manage complexity.

There are at least three additional broadly based concerns regarding the EA process that are linked to one another and that a more integrated design approach might address. They are: public participation, scoping and the integration of EA and land use planning.

The fact that an EA is required for public sector projects and not private sector undertakings has at least two significant implications. The first is, that as the private sector takes on larger and larger projects it is increasingly important to recognize that most of those projects are, as-of-right, exempt from an environmental impact assessment. The second is, that the proponent for a project is often a municipality. The municipality may find that the interests of its official plan and other considerations the Planning Act are at odds with its responsibilities regarding the EA Act. For instance, if a private developer of a subdivision requires a significant piece of supporting infrastructure, a major road for instance, this will trigger the requirement under Ontario

Regulation 345 /93 for an EA. “Municipalities should not avoid their EA Act requirements through the use of conditions on the Planning Act approval where the appropriate proponent for the work is a municipality”(Municipal Class EA Manual Section A.2.9.) This raises considerable questions about the legitimacy of both planning and assessment processes.

There is a growing consensus that EA needs to be integrated with the Planning Act and urban land-use planning processes (Lindgren & Dunn 2010, Winfield 2016, Municipal Class EA Manual). A decade ago the EA advisory panel recommended that municipal master plans and EA processes be better coordinated and several years later Ontario's Environmental Commissioner made a similar observation. He noted a, “poor integration between EA and the land use planning process…Municipalities are expected to consult with the public on Master Plans, but Master Plans do not require approval under the EAA - only specific projects within a Master Plan are subject to EA. Thus, in spite of the warning against piecemealing and the encouragement to think long-range, the approach tends to lead to fragmented decision-making. (Lindgren & Dunn 2010:301)

Unless and until municipal and regional land use planning and environmental assessment are integrated into a design methodology that employs a participatory, performance-based design method, issues of scoping and integrated ecosystem-based strategizing, assessment, monitoring and adaptation will elude the goal of the EA ACT to ensure the, “betterment of the people of Ontario by providing for the protection, conservation and wise management of the environment.”

Adaptive Management is an ecological research and implementation method that has significant potential to be adapted for design practices. The term applies across a broad range of disciplines and has its roots in environmental resource management, primarily fisheries and other water-based stocks. In large part because of its ability to reduce uncertainty, there is increasing interest in applying it to a broader range of environmental management processes and projects including environmental impact assessments (Olszynski 2010, Holling 2001, Gunderson and Holling 2002).

It is essentially a proto-typing method, where small scale interventions are made in natural and cultural systems after a process of analyses, proto-typical design, implementation, observation and learning. While one of the most commonly noted aspects of adaptive management is the abundance and range of definitions (Greig et al 2008, Cantor and Atkinson 2008, Olszynski 2010) the following is reflective of many if not most of them:

"In most environmental management domains…there are varying degrees of certainty regarding the effectiveness of our actions in achieving desired objectives – due to either gaps in our understanding, or changes in the ecosystems we're trying to manage. Adaptive management provides a way to systematically reduce this uncertainty. It is a rigorous approach for learning through deliberately designing and carrying out management actions as experiments, specifically to learn how the system responds to management and to increase the level of certainty regarding how best to achieve desired results (Walters 1986)"(Murray and Marmorak 2004 quoted in Olsynski 2010).

There is a recognized six step cycle (Greig et al 2008) of adaptive management that, like all good design processes, is iterative. While in theory the cycle can be stepped into at any point, it is easiest to understand as a process of: assess, design, implement, monitor, evaluate and adjust. The monitor and evaluate steps are easily recognized as ways of

learning, but in fact assessing, adjusting and most of our notions of designing, increasingly incorporate research and learning.

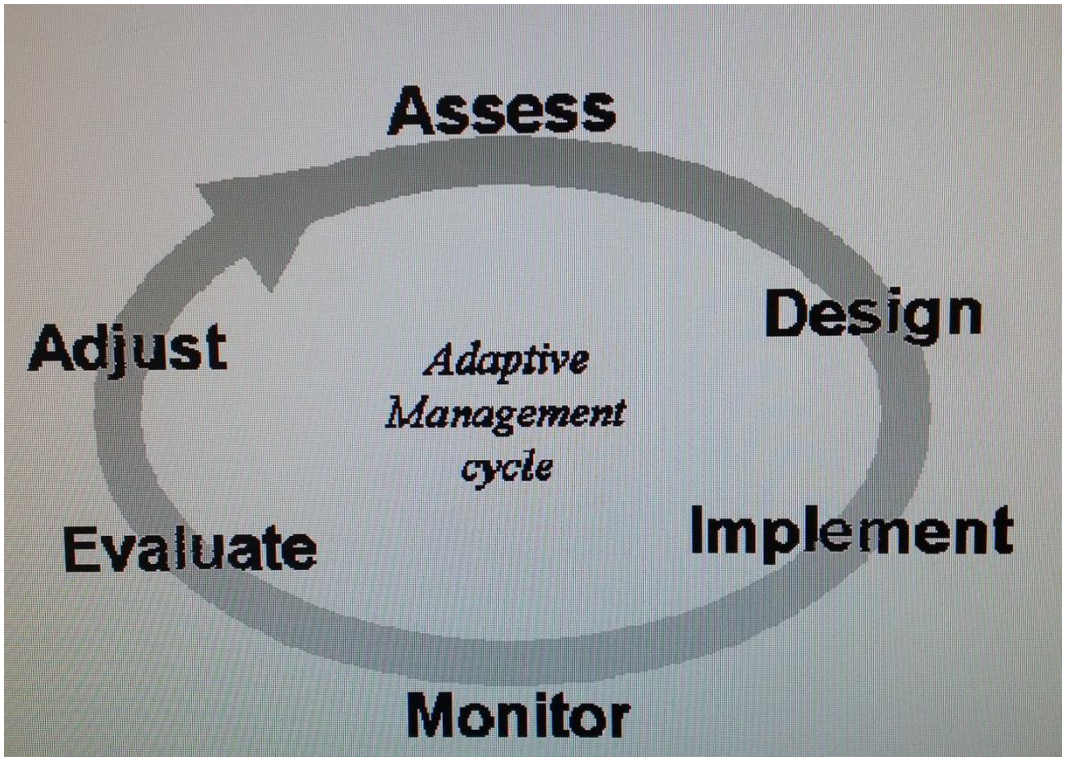

Figure 1 - Adaptive Management Cycle (Greig et al, 2008)

Each of the six steps can be expanded to include a number of tasks or elements. For instance as part of the assessment process, goals and objectives can be explored, indicators identified and stakeholders involved. The evaluation step can include comparing results against objectives, assumptions, hypotheses or baseline data and incorporating various kinds of statistical and analytics advice (Greig et al 2008).

Adaptive management has parallels and elements in common with the iterative process of many designers. A key component of the method is that it incorporates learning into the process. In my opinion this is what distinguishes it from many planning methods and

situates it within the field of design. It also involves deliberately pre-selecting an expected outcome, as one would when making a scientific hypothesis. This predicted outcome is then tested by means of monitoring and next steps are adjusted in response to the learning gained through this monitoring process.

Greig states that adaptive management "involves… making explicit predictions of… outcomes" (Greig et al 2008) while others state that "AM (adaptive management) is a science and performance based approach to ecosystem management in situations where predicted outcomes have a high level of uncertainty"(Canter and Atkinson 2008:4). While these generally accepted definitions of adaptive management include the prediction of outcomes as part of its process, the fact that the method acknowledges the need to learn, suggests that the hypothesizing is, like foresighting, more a speculative process of identifying probable outcomes than a method for predicting outcomes

A key advantage of the method is its ability to incorporate uncertainty into its process. "Adaptive management, on the other hand , is about embracing uncertainty in order to learn from it" (Olszynski 2010:2). It is the learning, not the reduction in uncertainty, that is the most important aspect of adaptive management.

Uncertainty can be due to gaps in knowledge. These can be knowledge gaps regarding cumulative effects or site or regionally specific carrying capacity (Cantor and Atkinson 2008). Gaps in knowledge drive the need to incorporate learning into the management of systems in which uncertainty is a constant factor. However the gaps in knowledge are not always due to a lack of understanding of the system but rather, to ongoing change

within the system. To complicate it further, changes to the system can be driven by externalities (Gell-Mann 1994).

The value of design as a management tool is in its ability to incorporate learning in its process. The success of design is predicated not on an ability to predict but on an adaptive, flexible capacity to incorporate learning. The decision-making process is open to change as opposed to fixed and predictive of change. If internal or external change occurs during the design process and the process needs to flex and adapt it doesn't mean a mistake was made during design. This is a radically different view than that of traditional engineering or rational planning. Adaptive management is adaptive in order to reduce uncertainty but it also takes uncertainty into account and both anticipates and accommodates learning in the monitoring step of the method. This is a key link to foresighting as a design technique, which also pre-identifies indicators and possible futures.

The language of Section 38 in CEAA actually supports the link between design and adaptive management. In situations of uncertainty, rather than simply selecting alternatives, the law actually requires that a responsible authority (RA) engage in design. Section 38 (2) “Where a responsible authority takes a course of action under paragraph 37(1)(a) it shall design a follow-up program for the project and ensure its implementation ….” (Olszynski 2010: 6).

In addition to incorporating uncertainty, a sine qua non of complex adaptive system, adaptive management also incorporates non-linear and cumulative effects into the learning process.

Cumulative effects

While cumulative environmental effects are required to be taken into consideration under the Ontario Environmental Bill of Rights, 1993 (Lindgren & Dunn 2010), this requirement is not mandated in either the federal or Ontario environmental assessment processes. This is a shortcoming that needs to be addressed and adaptive management may provide a method for doing so.

Adaptive management facilitates decision-making and strategic interventions across scales. The "overall system performance is enhanced as adaptive management reconciles project-level actions within the context of ecosystem-level responses" (Canter and Atkinson 2008:4). This attribute of adaptive management is one of the key requirements of a design method that is to be capable of dealing with unpredictable change over various geographic and temporal scales. It is a process that provides for deliberate, what I call strategic interventions, that can result in, "transformative change within complex systems" and accommodate, "a process of cyclical fluctuation, cross scale alignment and interaction with nested holarchies" (Ruttonsha and Quilley 2014:4) Holarchies being a term closely associated with panarchy (Gunderson and Holling 2002) or change within and across nested systems. As will be elaborated on later in the paper, this process is related in some aspects to variations of a Markov Decision Process (MDP) (Gell-Mann 1994) which addresses a chain of possible actions, their effects on states in various degrees of observability, and the rewards that accompany outcomes of those actions. The consideration of the MDP or a modified version of it, a Partially Observable

Markov Decision Process (POMDP) into urban design may provide expanded opportunities for a participatory, performance based design method.

Limitations of AM

There are limits to adaptive management and one of the most pertinent to its application in urban design is the risk that in attributing to it an ability to reduce uncertainty, it may be used inappropriately with respect to development projects. The very fact that complex adaptive systems incorporate uncertainty sets the bar very high in terms of the importance of understanding what is meant by the term predict when used in the context of adaptive management. The case has been made that because, "practical irreversibility is a characteristic of most development projects" then, "adaptive management is not appropriate in situations where impacts are likely to be unacceptable or irreversible" (Greig 2008:5) . While I agree generally with the sentiment, there are two points to parse in this argument. The more minor is that there is a difference between a project and the impacts of it. While the development project itself may not be reversible, the impacts may be. The second and more significant point to be made is regarding what needs to be understood by foreseeable with respect to impacts. The National Environmental Policy Act (NEPA) in United States points the way for other jurisdictions and their legislation, including CEAA and EA Act, when it specifically says that, "for the purposes of this section, "reasonably foreseeable" includes impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of

reason"(Cantor & Atkinson, 2008).This seems to indicate that probable versus predictable futures and impacts are taken into account. The importance of this is underscored by the statement: "… There is a fundamental difference between reducing uncertainty (i.e. learning) and actually reducing impacts" (Olszynski p2010:5). If there is no means to mitigate the foreseeable impacts of a project or management actions cannot be adapted, then adaptive management is not a reasonable option.

On balance, the two main limitations of adaptive management seem to be lack of recognition of what in fact are the "techniques" of the method and a minimizing of cumulative versus individual risk. Both of these limitations are summed up well in the judgment of the federal court of appeal in *Canadian Parks and Wilderness Society v. Canada (Minister of Canadian Heritage)*. While seen as a way of balancing the, "paralyzing effects of the precautionary principle on otherwise socially and economically useful projects" (Olszynski 2010:8), in fact the court seems to have misunderstood both of the above noted limitations. It concluded, "that when combined with mitigated measures and adaptive management *techniques* designed to identify and deal with unforeseen effects, any adverse environmental effects were unlikely to be significant…. I do not find it necessary to address (the variety of environmental harms) in detail here. Suffice it to say that, for the most part, the environmental screening assessment report ranked *each* of the risks is low…" Olszynski 2010:8 (italics mine). It's not clear what techniques the court thought adaptive management offered, in and off itself, to deal with unforeseen effects, other than of course to observe them and then alter management approaches. However, given the issue with the construction of a road, the

likelihood of dealing with unforeseen effects short of removing the road seems unquantifiable. In addition, relying on the fact that each of the risks was perceived as low, does not appear to recognize the important factor of unknown cumulative effects.

Other limitations to the method include an insufficient ability to monitor or to differentiate between the effects of different management actions on outcomes. (Olszynski 2010)

More significantly, adaptive management and the assessment of development projects can only be effective when those projects are understood as nested within an environmental management basket. In other words the needs and objectives set out in the environmental management goals of cities or regions need to be understood as primary over the needs of development projects. Urban design needs to be understood as a tool to frame the question of what are environmental management goals. An exploration of the differences in the perspectives of environmental economics and ecological economics would be a useful future research undertaking.

Performance Based Design

This section addresses the implications to each of the four research questions of what has been discussed. It provides a five step design cycle for performance based urban design which is based on a modified Markov Decision Process. As described previously, a Markov Decision Process (MDP) addresses a chain of possible actions, their effects on states in various degrees of observability, and the rewards that accompany outcomes of those actions. In the case of an MDP, all of the current states are observable. However, in the case of a city, the conditions are only partially observable, therefor a modified version of it, a Partially Observable Markov Decision Process (POMDP) (Spackova and Straub: 2016, 2017) is a more appropriate process to either use or draw upon for insight and possible applicability for a participatory, performance based urban design method.

Recent research into the potential to apply POMDP to issues outside of the disciplines where MDP has traditionally been applied (Spackova and Straub: 2016, 2017) show that flexibility has a higher utility value when both the degree of uncertainty and the possibility of future learning is relatively higher. This has implications for the economics of cities as it suggest that adaptive capacity is perhaps enhanced by building infrastructure that sacrifices efficiency in favour of flexibility. Or perhaps a better way of putting this, is that we have misunderstood the utility value of flexibility. This has parallels with the benefits of biodiversity. Biodiversity in an ecosystem can be (mis)understood as inefficient, because it effectively represents redundancy in the system. This also highlights the need to recognize and attempt to provide adaptive capacity in cities.

Creativity is a form of adaptive capacity and it embraces both future learning and uncertainty. The capacity for ambiguity and uncertainty provides an indicator that a design method that incorporates these qualities may be more appropriate to 'the kind of problem a city is' than the planning and architectural approaches that Jacob's cited, ones that have historically been less inclined to bottom-up, participatory methods.

Research Question #1

How might we re-position urban design as an influence on urban pattern through a focus on the performance of cities?

In order to answer this, we need to define performance in the context of design.

The term design, used in relationship to complex adaptive systems, needs to be understood primarily as a management process rather than as a process predominantly concerned about producing form. In order to manage something, one needs to measure performance (Gharajedaghi 2006). The implication therefor is that performance based design is a measurable process with targets and goals. This doesn't presume control of the system, but an intentional interaction with it, nudging it toward desired outcomes, all the while recognizing the uncertainty in the system, which uncertainty includes the shifting and changing of individual desires and intentions themselves.

Goals in turn, imply purpose which in turn is defined by values. The goals, purpose and values need to be those of the community of participants within the political economy and geography, the urban ecological context, of an urban design strategy. There are a

range of methods for determining or reaching consensus as to what the values of a community are, but it is critical to include participation in the process.

Performance-based design includes all of the steps in adaptive management methods that have been described in this paper. However, performance-based design is more than adaptive management, it also incorporates components of the master plan method described by Ian McHarg as well as aspects of the environmental assessment process discussed earlier this paper.

Most importantly it includes participation by all of the stakeholders in the urban system that is being designed. The interaction of the public and individual and institutional stakeholders, with each other as well as with all of the other factors and relationships of the ecosystem that they find themselves operating within, is what creates some of the most challenging dynamics of design for complex adaptive systems. When we engage in design, we are managing the outcomes of all of this individual and collective behavior.

While we can seek to measure the actual performance of a system, this is not the case with values. They are rooted in a complex mixture of personal and cultural desires and needs, objects, places, people and symbols. This whole, this mixture, can be tapped into in order to generate a collective purpose with legitimate goals. In “collective subjectivity is objectivity (provided that collectivity is representative of a variety of value systems.” (Gharajedaghi 2006: 177)

Based on the material we have reviewed, there are at least two examples of goals, rooted in meaningful purpose or values, that we can propose as both ecologically

defensible and likely to find broad public support: fitness and health (McHarg 1969, Mumford 1961, Howard 1945, Holling 2001). These two goals are increasingly being incorporated into municipal, regional, provincial and federal legislation or policy, such as the Federal Sustainability Strategy 2016-2010. The thirteen goals of this policy document can be largely summed up as variations on concepts of:

Clean (growth, drinking water and energy)

Healthy (oceans, coasts, wildlife and communities)

Resilient (infrastructure)

Sustainable (food, lands and forests)

Notwithstanding that there are some significant problems in describing one of the sustainable goals as sustainability, which is further interpreted as including biodiversity and ecosystem services and of a lack of distinguishing between the sometimes mutually exclusive aspects of healthy and safe, due to the risks involved in some healthy activities, this and other documents provide a starting point. Based on some commonly agreed upon goals and values, performance measures, criteria and indicators need to be developed for performance based design, but sustainability, health and fitness can potentially be representative of shared values and purpose.

"Performance criteria are the expression of what is to be monitored….performance measures are the operational definition of each variable – that is, how each variable is to be measured specifically" (Gharajedaghi 2006: 176-177).

City making requires: goalsetting, visioning, the construction of physical and mental models, public participation, environmental assessment, formulation of strategies and strategic interventions, monitoring, adaptive management implementation; taken together these are by design a creative process with intentional outcomes.

We can re-position Urban Design by re-affirming it as a process based practice and by providing strategies to better achieve public goals, such as fitness and health, that our review of current master planning and EA processes seems to indicate have frequently been lost. This can be done by establishing performance criteria and measures as targeted outcomes for urban design practices. The method illustrated in the modified Markov diagram contains the various components required for performance based urban design.

A performance based design method addresses many of the historic reasons for urban design failure identified in the previous research but it will need to address weaknesses in current methods as well. Urban and regional design practices need to better recognize the impact of cumulative effects, incorporate strategies to link performance across scales, set measurable performance targets rather than aim to mitigate adverse effects and take into account the achievement of objectives at a system scale rather than just a project scale. (Lindgren and Dunn 2010, Winfield 1016)

The design of complex adaptive systems, using performance based methods requires an understanding of design as a process that leads to strategic interventions. There will be a lack of direct control and certainty as to the outcomes but a performance based approach has the potential to address the urban design opportunities of cities and

regions by producing strategies that incorporate learning, imagination and adaptive responses to uncertainty.

Performance based design is a research approach to design and in this sense is a management tool. If adaptive management techniques were to be linked with foresighting and scenario methods of identifying possible futures and preferred outcomes there is potential for a dynamic design method to be explored. Urban design master plans have a tendency to be brittle, a combination of master plan, EA and AM methods can help manage through design our way to a preferred future in a series of adaptive decisions and interventions that respect the complex systems nature of the ecosystem that cities both comprise and are nested within.

Research Question #2

What is the manner and extent to which urban design practices are process based as compared to those guidelines and master plans that are form based?

There have been attempts, ranging from McHarg's method of master planning through various environmental assessment processes to adaptive management, to incorporate process into urban and regional design practices, but these have been limited in their success. Some of the reasons for this include: a lack of integration of the various components of each of the methods explored into a single method; a lack of effective implementation of the various components of these methods, perhaps most especially, public participation; an inability to recognize participation itself as both a component of the methods and a characteristic or dynamic attribute of the urban system itself; a

corollary of the lack of effective participation is a lack of consensus regarding the values that underlie the goals and objectives of urban design.

It is important to recognize that design is both a noun and a verb. As noted earlier in this paper, neither the EA or AM methods are understood as design methods but they both identify a step within their method as “design”. This use of the word design recognizes only the formulation of a design. The grammatical cue that form is central to this step is in the word formulation itself.

A design is the expression of a design process.

Design is the creative process that humans engage in to intentionally affect change (Buchanan 1992). This process is given expression when we say something was done by design. Formulation of a design is only one part of the design process.

The activity of design is an intentional process that when applied to a simple or complicated problem is expressed as a form that can be predicted. When it is applied to complex problems the expression is emergent. The intentional intervention in a system *results in* a change in the pattern, scale or rate which is expressed as a form. This holds equally in evolutionary terms for the unintentional interventions of mutation or natural adaptation.

An outcome results from a process, at a particular moment in time, however that outcome isn't necessarily a design. When the process is an urban design process, that outcome is both a design and at a larger ecosystem scale, a change in the fitness of the ecosystem. The intent is to both formulate and implement a design as an intervention in

the system, and to change the system itself so that it becomes more fit (McHarg 1969, Gell-Mann 1994).

> "It is too simplistic to suppose the complex adaptive system merely slides downward on the (fitness) landscape. When entering a depression, the system would move steadily downhill until it reaches the bottom, the local maximum fitness the region from which downhill motion leads to that spot is called the basin of attraction. If the system did nothing but slight downward, it would be overwhelmingly likely stuck at the bottom of shallow basin. On a larger scale there are many basins and a number of them may be deeper (and therefore more fit, more "desirable") than the one the system has found… How does the system get to explore those other basins?" (Gell-Mann 1994:266)

Gell-Mann suggests that thinking, specifically creative thinking and the ability to formulate problems, not just to solve them, is one way to prod the system and explore those basins. He identifies four characteristics of people who succeed repeatedly in the realm of creative ideas: "dedication to the task, and awareness of being trapped in an unsuitable basin, a degree of comfort with teetering on the edge between basins, and capacity for formulating as well as solving problems." (Gell-Mann 1994:269)

When intentions or goals shift, or are ambiguous, the activity of design must reflect these changes. In this adapting, the process of design manages change in the pattern of human thought. While urban design practices incorporate some recognition of process, there remains a continuing lack of recognition of "the kind of problem a city is", that is, complex; an apparent lack of consensus that the goals of urban design are rooted in values versus form, for instance the goals of fitness and health; a political instrumentalism that has largely removed both effective public participation and an assessment of the question of need from EA processes in Ontario; and challenges taking cross-scale and cumulative effects into account.

Research Question #3

How can Urban Design address uncertainty?

Incorporate **learning, adaptive responses** and **user participation**.

A scientific research approach to design is about understanding systems by merging current knowledge and speculative predicting. Engineering and planning approaches are about controlling systems by incorporating current knowledge. Design approaches incorporate imagination and responsive feedback through participatory foresight methods.

"If planning requires the posing of alternatives with the costs and benefits of each, it is necessary to be able to demonstrate the physical and financial consequences of the status quo extended in the future… While it is an admirable device to be able to offer alternatives to society, it is also rather difficult to predict the future." (McHarg 1971: 80)

The methodologies of both design and adaptive management incorporate learning into their processes. This allows designers to fill gaps not in our knowledge of the way things are or were but gaps in our knowledge of what the system will become. In effect, learning allows the designer or manager of a system to adapt to change in the system by participating in it. At the same time as we observe and monitor our effects on system we are participating in the system. In this way adaptive management is not so much about reducing uncertainty, although it does that; it is a method that incorporates learning and feeds that new information back into the system.

Once we understand uncertainty as a dynamic function of change within the system it becomes apparent why iterative design methods that incorporate learning as feedback into the process are more appropriate for complex adaptive system and more likely to produce successful outcomes than a planning approach that is rooted in historic information. “learning and thinking in general exemplify complex adaptive systems that work, and perhaps the highest expression on earth of that kind of skill is human creative thinking”(Gell-Mann 1994:269). Learning is itself a complex adaptive system and has evolved as a method ideally suited for taking change into account.

As Marshall McLuhan pointed out, (McLuhan 1974) change can occur in terms of rate, scale or pattern. In many of today's environmental design projects, it is the rate of change that is most challenging to incorporate into the design process.

“…the challenge of circumstances that change more rapidly than a given evolutionary process can accommodate is one that profoundly affects the prospects for the biosphere and for the human race as a whole… The implication is that cultural change itself is the only hope for dealing with the consequences of a gigantic human population armed with powerful technologies. Both cooperation (in addition to healthy competition) and foresight are required to an unprecedented degree… Given the immense complexity of the numerous interlocking issues facing humanity, foresight demands the ability to identify and gather great quantities of relevant information; the ability to catch glimpses using that information of the choices offered by the branching alternative histories of the future, and the wisdom to select simplifications and approximations that do not sacrifice the representation at critical qualitative issues, especially issues of values. Powerful computers are essential for assistance in looking into the future, but we must not allow their use to bias the formulation of problems for the quantifiable and analyzable at the expense of important.” (Gell-Mann 1994: 305)

By using foresighting techniques to “catch glimpses” of the future, we effectively provide more time for decision making. Rather than the future arriving unannounced so to speak, foresight techniques identify, in advance, a number of plausible and possible futures and more importantly, the technique identify some possible signposts, in the

way of indicators, that are likely to emerge prior to that future itself arriving.This provides a mechanism for addressing the issue of rate of change. Once indicators are identified in foresight exercises, strategies for responding to the future can be prepared in advance.

Performance Based Design can also use foresighting and scenario creation techniques to incorporate user participation. Foresight incorporates imagination of the future into the design process. We imagine the future. Whenever I think about this it reminds me of Bruce Chatwin's *The Songlines*, (Chatwin 1986) in which he describes the participants of an aboriginal group, singing the future into being. Song can be an expression of imagination. In most design projects there is a process referred to as visioning, and this is surely what is being done, imagining our future into being. When participants engage in an urban design project they all bring a desired future to it. Their past experience is captured in their memory.

Foresighting is a way of anticipating the needs of participants in the future. In addition to the alternative designs of an EA method, urban design needs to enquire about alternative future needs and it can do this by exploring alternative future scenarios. Current methods of design frequently project current needs into the future, however, by exploring possible and probable future needs, a basis for alternative designs is inserted into the process. Scenarios seek to identify trends and indicators and in doing so help to incorporate uncertainty into the design process.

There are at least two typologies of participants engaged in urban design. There are the users of the ongoing urban design projects that are part of the complex adaptive system

of global cities and their associated networks of production, distribution and consumption (Hall and Pain 2006) – those who Slavin (2016) describes as being both in the traffic and the traffic and there are the “hired guns”, consultants and technical designers. The consulting designer has an experience bank that is focused on particular skill sets that are useful to articulate urban design; in that sense she is like a conductor, guiding and managing the input of the participants. Both the conductor and the choir bring deliberate intentionality to the project, but at different scale or intensities of focus. The conductor of the urban design choir seeks to nudge or influence the system towards a desired vision or outcome, and needs to be listening and receiving information as well as singing the world into being. The consulting designer’s role is to assist in transmitting the collective vision informed by the song emanating from the choir. Each member of the choir brings their own set of memories to the project.

Design is a process of imagination. As humans we are constantly imagining the future and remembering the past. This combination of mental constructs, rooted in physical and sensory realities, informs our imagination. Using imagination we are able to create scenarios. We are then able to back-cast from those imagined futures, informed by the memories that are themselves influenced by our imagination. This process of imagination and memory informs our constantly constructed present.

It seems reasonable to think of our present-aware selves in much the same way as wave- particle uncertainty. We are like passengers in the middle of a moving train, with our imagination “occupying” the front car and our memory the back, while at the same time existing within our physical body. This ambiguity informs our participation in

complex adaptive systems which themselves have ambiguous and uncertain attributes. This ability to imagine is a unique aspect of the adaptive capacity that humans bring to the complex systems that they both live within and are a part of. It is this ability to imagine the future and have imagination cascade back into the present and cascade back to our memories, altering and informing those memories, that makes humans capable of unique processes of design.

We are constantly engaged in a dynamic process of creating, organizing and interpreting an identity for ourselves and for the living system of the city. At either end of the spectrum of creating identity lie on the one hand memory and on the other imagination. It is in part because of this dynamic nature of creating identity that design itself is a dynamic process. Identity is constantly the being and becoming of all the desires, intentions, behaviors and expressed in the form of the system. The system includes the participants and the body of the system; both the city and the participants. As demonstrated, the city can no longer be understood simply through its form, process needs to be taken into account, and it is increasingly apparent that participation is a critical part of effective urban design processes.

Research question #4

Identify drivers of change in urban form

Change can be understood as either an adaptive or evolutionary process. Adaptation and evolution are responses to drivers and can be either intentional or unintentional responses. This paper is focused on intentional adaptation and specifically performance

based design as an intentional adaptive response. The design process is a response to the drivers and both a design and urban form are an expression of those responses. Strategic interventions are an attempt to manage the drivers of change.

Strategic interventions in the system manage the various drivers of change. This as compared to natural evolutionary processes which are unmanaged and result in unintentional novelty. These interventions, in exchanges of energy or information among other things, can be expressed as changes in pattern, scale or rates of heat, wealth, nutrients and structures. These exchanges, which occur from both within and outside of a system, have the potential to shift the system from one basin of attraction to another and in doing so, lower the entropy and increase the fitness of the system (Refer to modified Markov diagram). The interventions can be intentional, as in the strategic intervention of a design process, or largely unintentional, as sometimes is the participation of users in an urban system. In either case, the intervention of new information, energy or mass results in a change of pattern, rate or scale in the system. Alternately the intervention might activate a property or attribute already present in the system (personal conversation with Trevor Haldenby) which in turn results in a change of pattern, rate or scale in the system.

It is recognized that the various actors and stakeholders in urban design are participatory designers, (McHarg, Jacobs, Mumford, Slavin) they are users of the urban system and “users have behaviour, intention and desire” (Slavin: 6). Some have a role as managers or design consultants, and bring a range of technical expertise to individual urban design projects. This expertise includes sketching, illustrating, facilitation,

visualization and forsighting techniques. Some bring a combination of these participatory roles and engage with the city as with an organization. In doing so, the designer can function as a participatory designer or as a manager, aligned with management bureaucracy of government or other agents. Humans then, as participants or management agents are a key driver of change and are accounted for in performance based design.

> "An organization does behave in many ways as a complex adaptive system, with schemata and selection pressures.… and generates mental models for the functioning of the whole enterprise. The models, together with goals, plans, practices, and procedures, constitute schemata, subject to direct pressures exerted by managers at various levels… In general, when organizations are regarded both as complex adaptive systems and as theaters for the exercise of the management skills of individuals, the question arises as to the relationship between the ultimate selection pressures that govern the survival of the organization and the internal selection pressures exerted by the individual managers" (Gell-Mann 1994:298)

A city is a living system, and teasing apart the actors, stakeholders, components of the system and their relationship to each other and to the broader ecosystem is a challenge for the various reasons already noted. However, in addition to those issues, there is also the significant factor that some components of the system have intentionality and some don't. The issue of intentionality affects the goals or perceived objectives of both the participants within the system and the system itself. While we can readily understand a city as being comprised of cultural and natural components there is a very real sense in which the urban system is a component of a whole system that in its entirety is nature. Nature includes humans with their culture and various kinds of intentionality. Nature also includes components that we tend to think of as natural, some of which have intentionality and some of which do not. We can think of many faunal components that clearly have intentionality and we can debate the intentionality of flora. We can even

debate the intentionality of the broader system that includes geomorphic and geologic processes and forms. However, when we use the term design, this implies and demands intentionality. (Dewey 1929, Buchanan 1992)

Emergence is a property of a system and doesn't require intentionality or goals. One cannot design emergence, but it can be accommodated in the design process by providing for learning and adaptation. If nature pursues anything, it seems to be novelty. As humans we pursue things other than just novelty. There is a pursuit of identity throughout the breadth of human history, in the history of human communities and in the drives individuals. All living things adapt and change in response to their environment and to other individuals within that environment.

Design is human intentionality (Dewey 1929, Buchanan 1992) applied to the system. It is a process of exchanging information. A design is the symbolic expression of the intentions of multiple players and when implemented results in the creation of places and spaces for the relationships between people and their individual and collective relationships with environment and broader natural forms and processes to be acted out.

In cities, humans seek to create identity through their behaviors. Some of the drivers of those behaviors are intentional and some are not. They are informed by memory and imagination, desire and intention, subconscious and conscious ideas and behaviors.

Human self-awareness and identity informed by imagination and memory bring intentionality to the system and this is a driver that differentiates the complex adaptive system that is city from a wild place.

The intentional input described can include emotional inputs such as desire and is a strategic intervention (see Performance Based Design diagram) which creates a feedback loop. This feedback loop is what makes the design process adaptive. The intervention is a design, but the creative process illustrated, which incorporates a participatory process throughout- especially but not exclusively in the Goal Setting, is the performance based design process.

The intentional input results in both an end product of form (a design) at one scale and unpredictable outcomes or effects on the complex adaptive system as a whole. In other words the formal input to a complex adaptive system requires that the results of that input be monitored and adapted to, if the intention of the design process is to manage or nudge the entire system to a preferred but not predictable outcome.

The management of the outcomes at both scales is addressed in this method of design for performance.

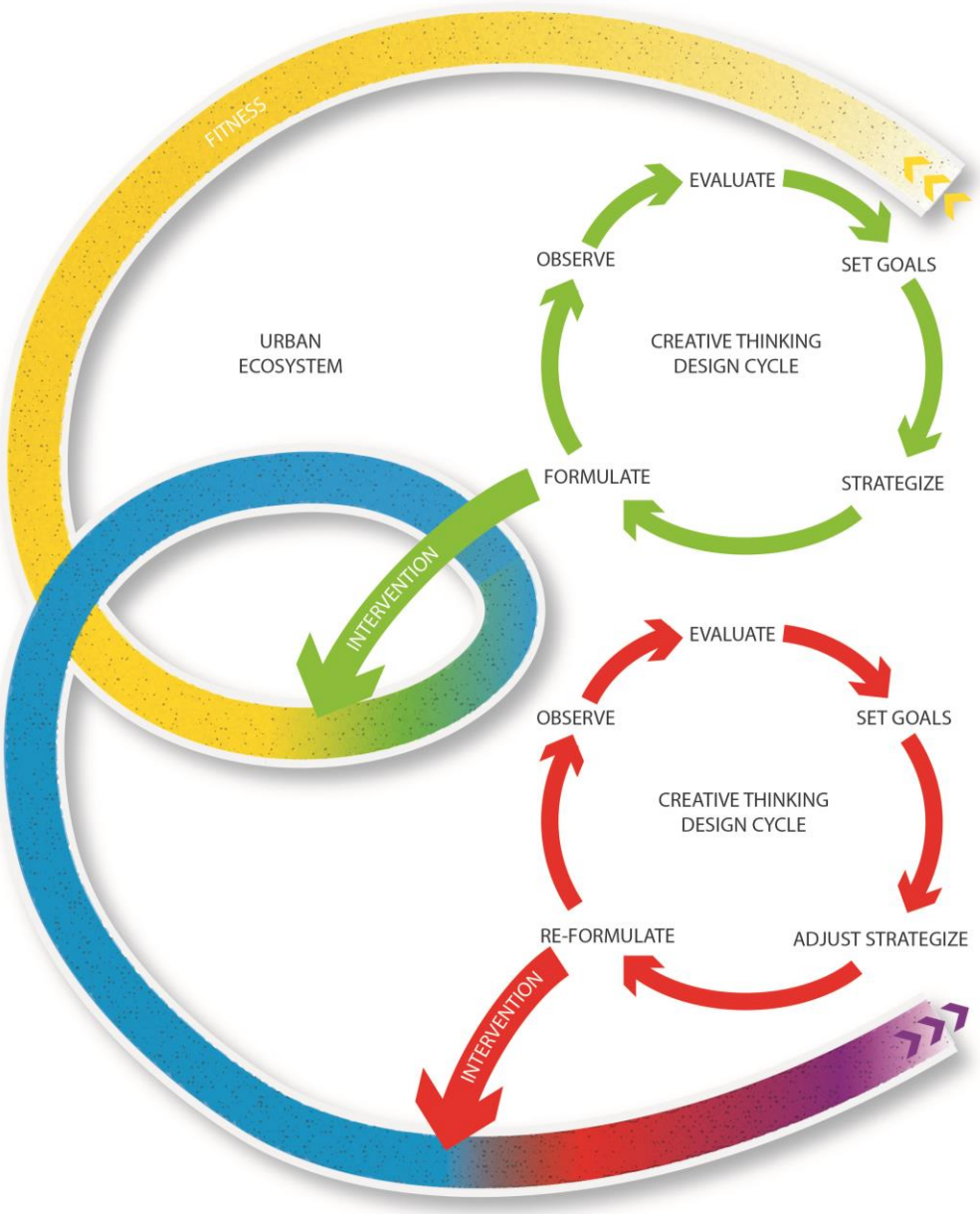

Figure 2 - Performance Based Design as Partially Observed Markov Decision Process

Conclusion

The form of communities can be described as an expression of their fitness. "…not only is there an appropriate community of creatures for any environment… but the community is, in fact, expressive of its appropriateness, it's fitness." (McHarg 1971:170)

Performance based design recognizes the potential to incorporate adaptive changes into urban design in order to enhance life. "If the purpose of fitness is to ensure survival and evolutionary success for the organism, the species, the community and the biosphere, then adaptations are primarily directed toward enhancing life and evolution…. When we link form to life we must retreat to a more basic but united concern with adaptation as creative or destructive. Fitness is then by definition creative and will be revealed in the form of fitness that is life enhancing." (McHarg 1971:173)

McHarg notes that humans can intervene in the environment in such a way as to increase what he calls "thermodynamic creativity" (McHarg 1971:163) This anticipates Gell-Mann's perspective about creativity in design process, which informs the understanding that strategic interventions into environmental fitness are an important aspect of design and reinforces the potential for applying methods to urban design that incorporate considerations of a Partially Observed Markov Decision Process.

The *need for* various types of infrastructure – transportation, power, landscape – is driven by the *needs of* the various stakeholders and negotiating these stakeholder needs is an important aspect of performance based design.

Foresight takes into account changes in peoples' needs. Needs for storage, conveyance, production and consumption of energy, food, water and waste. By taking account of change in needs, not simply current needs, the future is accommodated in the design process. This is more than simply providing alternative designs, it is providing for alternative, future needs. In addition, by anticipating future needs and possible future scenarios, foresight also provides a mechanism that takes into the rapid rate of change in urban systems. Foresighting methods identify possible indicators of possible futures which allows for participants in urban design to prepare adaptive responses in advance. This is a significant advantage in urban design which traditionally has addressed changes in scale or pattern but has been challenged to incorporate rate of change, the third aspect of change that McLuhan identified.

Moving forward, there is a need for improved integration of performance targets across political and geographic scales.

There are opportunities for performance and research based design to bring an increased emphasis or focus on measurements of exchange at local, regional and national scales, rather than measurements of production, such as GDP. In parallel with this, next steps in the pursuit of performance based design could include further enquiries into strategies to integrate social and ecological fitness, health, justice and emotional well-being into urban design performance objectives in order to supplement or supplant the driver of economic efficiency.

The possible difference in impact of ecological economics compared to environmental economics on urban design also offers a deep reservoir of potential future urban design research.

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