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Indicators for Sustainable Communities: A Strategy Building on Complexity Theory and Distributed Intelligence

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ABSTRACT *Indicators and performance measures have become an important element in policy initiatives relating to sustainability and to the re-invention of government. This article reviews the research and practice of indicator development and use, summarizing several key lessons from this review. One of the key lessons is that to be useful, indicators must be developed with the participation of those who will use and learn from them. The article then proposes a strategy for community indicators based upon the conception that cities are like living organisms functioning as complex adaptive systems. Three types of indicators are needed. System performance indicators are required to provide information to the public about the overall health of a community or region. Policy and program measures are required to provide policy-makers with feedback about how specific programs and policies are working. Rapid feedback indicators are required to assist individuals and businesses to make more sustainable decisions on a day-to-day basis. There is no simple formula for how to develop a system of indicators. Each community and region should develop a system based upon their own circumstances and needs.*

> Buyers, sellers, administrations, streets, bridges, and building are always changing, so that a city's coherence is somehow imposed on a perpetual flux of people and structures. Like the standing wave in front of a rock in a fast-moving stream, a city is a pattern in time. (Holland, 1995)

The Community Indicators Movement

In the 1990s an international social movement on community sustainability emerged. Both spontaneously and with the urging and financial support of foundations, non-profit national and international organizations, public agencies, citizens, and stakeholder groups have been gathering in the USA, city by city, for several years to develop their own approaches to making their communities sustainable. The European Commission has developed a set of recommended 'common indicators' on sustainability for local communities to adopt (Expert Group on the Urban Environment, 2000) These efforts are part of a worldwide movement for sustainable development, with each working independently, linked through networks and collaborations across national, regional, local

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and even neighborhood levels. While there remain disagreements about how to define, much less to reach, a sustainable society, there seems to be agreement that indicators will play a key role. Indeed, much of the work of these projects has been devoted to the development of community indicators, often collaboratively designed by and for the people in each place.[1] Handbooks have been prepared to assist local efforts (Hart, 1999; Redefining Progress *et al.*, 1997) and a newsletter has started.[2] This movement is developing so quickly that little has as yet been published documenting, much less critically evaluating, these experiments or assessing their impact.[3] The Internet is a better source than the library for finding out about much of this work, although its descriptions are sketchy and reflect the image each group wants to offer.[4]

Dozens of articles can be found proposing 'ideal' indicators on one issue or another, and substantial public resources in the USA and in international organizations have gone into defining and producing specific measures. Community indicators projects by the same token typically focus on getting out an indicators report, as if the numbers themselves would be enough to make change happen (the term 'community indicators' is here used as a broad term, covering efforts at different scales). Groups sometimes produce reports with dozens or even hundreds of indicators and then are stumped about what to do next. They know they want the indicators to become part of a public dialogue and somehow to help communities and regions become better at self-management and more self-conscious about the direction they are going. They want the indicators to be influential, but are without strategy for this.

Unfortunately these indicator projects typically do not build on the experience with indicators and with efforts to use technical information in public policy over the last 50 years. This history shows that millions of dollars and much time of many talented people has been wasted on preparing national, state and local indicator reports that remain on the shelf gathering dust (Caplan, 1975, 1977; Innes, 1990a). These efforts, like many technical reports for public policy, have relied on a simplistic model of how information drives policy.

While many indicator reports have been little used, a few indicators have had significant impacts on public action, and one can learn much from how and why these processes worked while others did not. Their influence came through a more complex and less observable process than even those involved recognized and only occurred when a variety of conditions were in place. Indeed in many of these cases it was not the indicators themselves or the findings of the reports that mattered the most. Rather, it was the learning and change among key players that took place during the course of their development and the new shared meanings and changed discourses (Innes, 1988a, 1990) that often made the critical difference.

Purpose of this Article

The purpose of this article is to outline a strategy for community indicators which would assure that such indicators can be influential and can contribute to sustainable communities. Our ideas build on the empirical and conceptual work of scholars who have studied the development and use of indicators and technical information over the last 20 years (Caplan, 1975, 1977; Dutton & Kraemer, 1984; Innes, 1988a, 1990, 1998; Innes *et al.*, 1994; Ozawa, 1991; Sabatier, 1978; Weiss, 1977, 1979; Weiss & Gruber, 1984). They also build on Booher's learning from his practice in which, as a consultant, he works to influence public policy. We are also influenced by literature and new practices of performance measurement. Finally our framework is drawn from the emerging thinking of com-

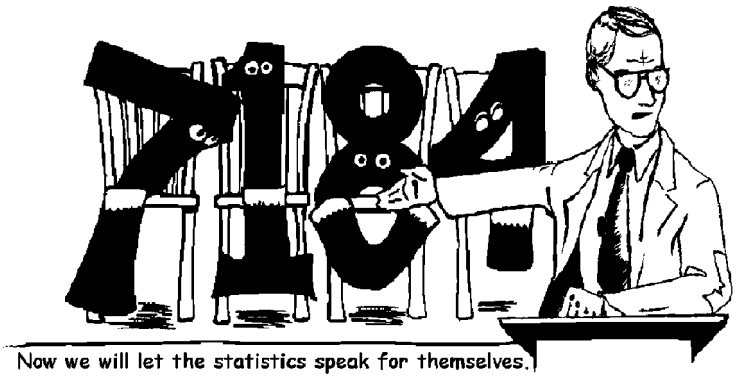

Figure 1. People, not numbers, do the speaking.

plexity theorists, who see the natural world as an organism, growing, evolving and even learning on its own as it responds to its environment.

We believe that the sustainable community will be promoted where many players in different roles and with differing interests and values are all provided with a flow of meaningful information, and where they have the opportunity for joint learning and innovative responses to this feedback from the environment and from other changes. It is this distributed intelligence which allows players in a community to anticipate and constructively address both individually and collectively the systemic problems the community continually faces and to deal with the threats and opportunities of natural and manmade disasters, the shifting global economy, and inequitable distributions of resources. What exactly those responses should be we do not know. Nor do we know what a sustainable community of the future will look like, nor what are the best indicators of it. We do think, however, that those who come after us will have the best chance to create sustainable communities if we create the information system to make it possible. Indicators are a tool to accomplish this.

Typical Approaches to Indicators

The literature deals mostly with the design of indicators. It focuses on developing a particular kind of output and pays little attention to the process of indicator production or the ways in which the numbers might become influential in practice. One conception is that all-purpose indicator reports should be prepared, including often dozens, or even hundreds, of indicators, listed by category. These are designed to be widely distributed. They might be produced by experts or by collaborative community based groups or some combination. The tacit idea is that these compendia, once available, will inform the public and assist analysts and decision-makers, who will consult the reports, learning from whatever information is relevant to the problem they happen to face. The European Common Indicators project is a case in point (Expert Group on the Urban Environment, 2000).

A second idea is to design one indicator to sum up the quality of life in a place or the value of its output by combining important features of a place in a single composite, aggregated measure. The use of Gross Domestic Product (GDP) is one such example. The effort of *Redefining Progress* to develop an indicator, *the GPI (Genuine Progress Indicator)*, that reflects real progress as opposed to including and weighting equally polluting and

clean up activities, is another example (Anielski & Rowe, 1999; Cobb *et al.*, 1995). A third approach is to develop separate indicators on the status of particular problems (rather than try to be all encompassing) so we can be aware of how they are changing, like the unemployment rate, crime rates, or poverty levels, or housing affordability. Finally a movement to *re-invent* government (Osborne & Gaebler, 1992) emphasizes the development of measures of performance and customer satisfaction with government. This spreading re-invention movement differs from the other views of indicators in that it emphasizes dialogue in the design and use of measures and in the interpretation of these in a complex, changing context. It does not advocate the use of indicators to guide a top down control system, but rather to facilitate the work of many players to make better choices, solve problems, and be better able to respond to context and change.

There have been many problems with most of these typical ways of approaching indicators. The all-purpose indicator report is seldom influential. It may provide rhetorical points for speech makers and general education for those who know little about an issue (de Neufville, 1986), but typically influential players do not read it, much less act on what they find out from it. Moreover it is enormously expensive and is not usually repeated. Without trend information, indicators have little meaning and in any case, an indicator report goes quickly out of date. Often aggregated measures have no meaning because to combine, for example, air quality, housing prices and school quality in a single index to measure quality of life requires a weighting system for which there is no clear basis (Landis & Sawicki, 1988). Sometimes aggregated indices gain currency because of their simplicity and because they seemingly allow comparisons between countries or cities. They usually cannot withstand modest critiques however, and accordingly they have not been widely used to actually influence policies, allocate funds or guide other decisions (Innes, 1990b). Any aggregated measure reflects a particular theory or set of value judgements about the society and what is important, and that may not be shared. While a small handful of aggregated indicators like the GDP are comparatively meaningful and do reflect shared values there are many disputed aspects. Moreover, they combine so many concepts that one cannot use such indicators to identify what is problematic or needs policy attention.

The commonly held idea that indicators can be used to evaluate how a policy is affecting the world is also a misunderstanding of what indicators can do. What they are is measures of characteristics of a community or society, chosen because these characteristics are valued and we want to know about them in and of themselves. Evaluation involves measurement and analysis of all the factors that may contribute to a policy's success or failure, along with careful design of research to isolate the policy variable from the other factors. An indicator may show improvement in community health for example but this improvement may have had nothing to do with the new hospital. It is important to know if community health is improving, but that in itself does not tell us what policy, if any, was a cause.

Lessons from Experience

Experience with indicators suggests that while aggregated measures are seldom influential, indicators on specific topics can be important, if they are transparent and methodologically sound and build on the way decision-makers think. Another approach that has been effective is the concept outlined by Osborne & Gaebler (1992), who propose indicators to track the activities of public agencies while also applying sophisticated diagnoses and responses to problems identified. Broad indicator reports can

sometimes be of community value, but only if a number of conditions are met. They have to be produced collaboratively, have public attention, and become an institutionalized part of the work of an agency and of the interests and players associated with it (de Neufville, 1986; Innes, 1988a; Weiss & Gruber, 1984). The report and its findings are essential, but its influence comes through the deliberation and production process and as a consequence of the ideas becoming part of the discourse, and taken for granted by the participants. As the ideas become taken for granted they have their strongest impact on action.

Some indicators have been influential in ways that have been clearly identified, including the national unemployment rate, the GNP as developed in the 1930s, and the consumer price index (de Neufville, 1975). Information on human rights abuses has had an impact through the US State Department's Country Reports (de Neufville, 1986) and data on race in schools have had an effect on policy related to discrimination (Weiss & Gruber, 1984). Technical information has had an influence in collaborative decision-making in certain science intensive disputes (Innes & Connick, 1999; Ozawa, 1991), in development of growth management plans (Dutton & Kraemer, 1985), in broadly enlightening decision-makers about the issues (Weiss, 1977) and undoubtedly in many other ways that have not been documented. However, a significant literature shows how many indicators, reports and technical analyses have not been influential (Innes, 1990). While indicators of crime for example are often cited, they seldom influence any public decision, provide enlightenment, or change anyone's mind about how to fight crime or how to train police (de Neufville, 1975).

If we look at experience with information which is influential and that which is not, a number of conclusions emerge (see also, Cobb & Rixford, 1998).

- *Indicators do not drive policy.* People are not suddenly converted because they are confronted with data, no matter how expertly nor how collaboratively designed. Compendia of indicators are not used by policy-makers as aids to decision. Conversion and learning requires more than reading a report or seeing an indicator.
- *Indicators can be influential under certain conditions.* Indicators must measure something publicly valued. Their users must be involved in their design. Their meaning must be understood and shared among those to whom they are relevant. They must stand up to expert critique. They must be trusted by all players. They must be linked conceptually and practically to actual policies or potential actions. There must be a place in the decision/action process where they are to be discussed and linked to action.
- *Indicators' main influence is not primarily after they are developed and published, but rather during the course of their development.* The process of debating the design of indicators shapes the players' thinking about the policies. Agreement on indicators helps get agreement on policy. The production and discussion of indicators in an agency or in the public arena focuses organizational and political attention on the issues they represent, and gives them legitimacy. Their use can change the terms of public discourse over the long term (de Neufville, 1975; Innes, 1988a).
- *If an indicator is to be useful it must be clearly associated with a policy or set of possible actions.* There will never be agreement on an indicator unless there is agreement on policy. The indicator does not lead to the policy, but agreement on policy can be advanced by discussion of how to design indicators. The ideal method may be to develop the policy in the process of developing the indicator.
- *Indicators influence most through a collaborative learning process.* This learning occurs in the design and production as well as in the process of making sense of what the

indicators show. Indicators are not influential just because they are well designed or because they show something surprising, or even because they focus on a topic that is of public and policy interest. They only influence when they become part of the thinking and ordinary decision making of the players. This only happens if the players were involved in developing them so they can relate them to their own contexts and perspectives.

- *It matters how the indicators are produced.* Both anticipated users and representatives of those with different stakes in the issues must be involved in the design of the measures and planning for their implementation if the indicators are to be influential. They need to reach agreement on both methods and concepts. If this is done by experts alone, indicators do not influence action. If it is done without experts, the indicators are not credible and not used.
- *For indicators to be used there must be not just opportunity, but also a requirement to report and publicly discuss the indicators in conjunction with policy decisions that must be made.* If this sort of required linkage is not made and followed, the indicators will never become part of the debate. If the indicators start moving in a direction that is politically problematic the producing agencies will stop publishing them.
- *The development of an influential indicator takes time.* Five to 10 years is an estimate for an important indicator to be developed in these collaborative ways, linked into policy, and to start to make a difference.

Participants in policy-making do not use indicators in the simple way that has long been envisioned for good reasons. They realize that the world they face is complex and constantly changing, that opportunities and problems evolve, players change, and that understandings of that world change. They know that indicators represent at best only a small part of what they need to pay attention to. Where they need help is in understanding the nature of this complexity a bit more, in order to develop indicators that will make a positive difference. The theories of complexity that are emerging from science offer insights that can lead to a more productive strategy for community indicators than has guided most of this work thus far.

Complexity Theory as a Guide for Community Indicators

Most of the ideas about indicators have been grounded in a metaphor that the world is like a machine that can taken apart and fixed. The idea of indicators is to measure different parts of the machine and their purpose is to help us find out what part of the machine is not working, and to fine tune policies to make the machine produce the right outputs. Complexity theory, however, suggests that the world is more like an organism, growing, evolving and adapting to its environment and that policies fail because of random events, unanticipated technological change or patterns in the economy (Bak, 1996; Holland, 1995, 1998; Innes & Booher, 1999). It focuses our attention on the fact that there are many diverse players who make the city what it is. Business people, residents, commuters, elected officials, among others, make millions of decisions each day which add up to the evolving form, structure, and character of cities, and which collectively shape their economies, their vitality and their evolution. These decisions are largely beyond the reach of any formal urban policy or plan, much less of any top down regulatory strategy. The best planners can do is to help the players in these places to influence the direction of change.

Indicators can play a critical role in helping cities and regions become adaptive

learning systems. Complexity theory shows us how a distributed network of agents, each with little knowledge individually, can produce outcomes that are coordinated and that demonstrate more intelligence collectively than any individual. Many agents in such a system, following simple rules for adjusting their actions without seeing or understanding the dynamics of the larger system, can produce a self organizing strategy that effectively deals with a complex and 'out of control' environment (Kelly, 1994). For example, flocking behavior of birds can be mimicked with a computer by applying to each simulated bird a few simple rules like 'do not bump into another bird' and 'keep up with neighbors but do not stay too close'. The results are so realistic that biologists have concluded that real birds also operate by such algorithms (Kelly, 1994, p. 11). Ant colonies are made up of hundreds of thousands of creatures with tiny brains, yet they form into complex social systems with hierarchies and specializations of labor. Each ant plays a part, and the colony survives, reproduces, and adapts to changing conditions. Chess playing programs can play much smarter games than their programmers because they learn by doing and evolve strategies the programmers did not anticipate (Holland, 1998).

Dumb parts of a complex system work together to improve the system so *long as they get feedback and so long as they have a capacity to respond*. So long as agents, whether they are people or molecules, share a general purpose (such as survival), can get feedback from their actions, and then can act differently (whether intentionally or by random tries), the system they are part of can become an adaptive, sustainable system. The spontaneous action of individual agents responding to their environment can result in more rapid response and effective change than a more cumbersome approach of designing and trying to implement carefully wrought plans and programs.

Indicators for Managing in Complex Urban Systems

Urban sustainability needs to be seen as a product of many actions of the participants in the city. If we want to change aspects of the city—its land uses, travel patterns, or use of resources for example—complexity theory suggests that a top-down intervention or applying an *a priori* plan will either not make much difference or it will have an unpredicted and possibly counterproductive effect. Planning practice and experience often confirms this. A complex system like a city is capable of improving *itself*, but such adaptation requires feedback—various kinds of information—to flow among the players (Innes & Booher, 1999). This is where indicators come into the picture—to inform those players as they go about their business and create a system of distributed intelligence so that the city can be, not just a complex system, but *a complex, adaptive learning system that can be sustainable in the face of unpredictable futures.*

We propose therefore that three tiers of indicators be developed, each of which will provide information relevant to action of different types. In the top tier, a small number of system performance indicators are needed—a few key measures which reflect the central values of concern to those in the city and which can serve as bellwethers for the health of the overall system. In the second tier is a set of policy and program indicators. These reflect the activities and outcomes of various elements of the system. These allow policy-makers and public officials to assess whether they should adjust their decisions and help with troubleshooting when results are not moving in a desirable direction. In the third tier are rapid feedback indicators to help individuals, agencies, and businesses to make the best choices for their own daily actions.

System Performance Indicators

A system performance indicator is one that reflects how the system is working. It should be understandably related to a shared and basic community value. A system indicator can be an aggregate or simply a measure of something that varies with the outcome of interest. For example instead of measuring quality of life as a composite of housing, weather, economy and the like, one can measure satisfaction from a survey of people's perceptions and attitudes. Or alternatively a measure like in-migration levels or the numbers of people that are moving out of a city might be an indicator of quality of life. Total waste generated could be a simple indicator of resource consumption, while also reflecting public attitudes and responses to the challenge of sustainability. The number of such measures is necessarily limited because of the public time and energy needed to develop them and because public attention to the results is not infinite. Their purpose is to provide a shared sense of direction for the community

These should be measures of *system* performance, as opposed to merely of the existence of one problem or another. A system indicator is one that can help the community to see how the system is working and anticipate potential breakdown or changes in direction. For example in the San Francisco Estuary Project, the consensus building group which had the task of developing a management plan selected the salinity level of the Bay at a certain key location as their indicator because it was critical to the biodiversity of the whole system. If this indicator was going in the wrong direction, it would mean that biodiversity was about to decline (Innes & Connick, 1999). Another example is VMT (Vehicle Miles Traveled) as an indicator of the sustainability of the transportation and land use patterns of a metropolitan area because it reflects the complex relationship of the use of transit, sprawling land use patterns and the potential for air pollution. To establish such indicators requires broad agreement among a wide range of participants on what kind of city they want. Do they seek a thriving economy without great extremes of income distribution? Or perhaps they want a community where all are engaged in the civic and political life? Or maybe they are looking for a humane city where education and opportunity thrive?

While determining a shared mission may be difficult, it is far from impossible, particularly with professional help at facilitating the discourse. Places have their own cultures and unique qualities as well as problems, and such strategic visioning can often be done consensually. In this process it is critical to involve stakeholders and experts in a joint effort to understand how the urban social, political, spatial, economic, environmental system works. These people should also develop ideas about what implications a particular indicator will have for policy. For example if VMT is selected, how is that likely to reflect on policies for supporting transit or highways, or for local control of land use decisions? There will be no agreement on VMT until key players understand and accept the consequences of using it. But on the other hand if the players do accept VMT, and if it comes to be equated in most players minds with discouraging sprawl, encouraging transit or simply providing sound transportation policy, it can be a powerful motivator of action.

The trick is to stick to a simple and conceptually clear indicator that can be widely understood and accepted by both the experts and the stakeholders, reliable, valid, and methodologically sound (Innes, 1990b). It is also important not to avoid controversial discussion and end up with lowest common denominator indicators that have few implications. System indicators require substantial public discussion and, ultimately, consensus among important players because they reflect, or even help create, shared

community values in a way no expert-driven indicator can do. Unless they are developed consensually and with ample discussion, these indicators will not serve the crucial purposes of framing public discourse and permitting joint learning. This discussion is crucial to assure that the indicators and the ideas they represent become integrated into actions of a community and its leadership. Community members have to equate these indicators with the things they value and use them routinely as part of their language and guides to action if they are to have influence (Innes, 1998). If they do so then the indicators influence the players in pervasive ways and help assure that they work in a coordinated way toward community objectives.

Policy and Program Indicators

The second type of indicator that we propose is one that will allow policy-makers to see both the outcomes of policies and programs and the state of particular subsystems, like transportation or housing. These indicators will allow those who are responsible for these subsystems to analyze what is going on and diagnose causes of problems. For example, these indicators might focus on the quality of parks in a city or on the transit systems. They would look at customer satisfaction, cost effectiveness, or measures of activity or usage that will help the agency staff, elected officials, and interested members of the public to understand, for example, how park maintenance, is being done and provide clues about why some parks are in a deteriorating condition. These are indicators that allow the responsible actors to make adjustments in their daily actions and set priorities. These indicators provide feedback to the leadership so they can say whether a policy is moving in the right direction, at the right pace, or identify problem areas where staff need to develop some new approaches. These are not definitive performance assessments of a policy or program, but part of a set of information that the experienced policy-maker or planner uses to make sense of many interlinked activities and ongoing events. For example, the numbers of vacancies or length of the waiting list for public housing might be performance measures for housing officials, along with monthly maintenance costs. If these were getting unacceptably high, elected officials can say so and ask that more investigation be done of associated indicators that could provide clues as to whether the causes are poor janitorial service, vandalism, poor management, or changes in the population. Other indicators, like complaints from residents, the time needed to respond to them, turnover among employees, or crime reports might be used to further diagnose problems and provide guidance for response.

Unlike system indicators, several of these policy/program indicators on any given topic can be useful and feasible to develop. These do not, for a number of reasons, require the degree of consensus, reflection and system understanding that system indicators do. There will be a variety of program indicators used at the same time so inadequacies of one can be compensated for by others. They will be used by those who are knowledgeable about the programs and interpreted in the light of many kinds of information. Most do not have to be specially designed because they will be ordinary outputs of the daily activities of an agency. Sometimes special surveys of satisfaction or outcomes might be done however, or new ways of compiling or tabulating information might be required. The goal in designing policy/program indicators is mainly to assure that the measures are meaningful and that they will be timely, useful and relevant to the decisions that face the players. As with system indicators, the process of selecting as well as using the measures is all part of the learning that is essential to assuring that the indicators have shared meanings and are a focus for discussion. This, in turn, will help

the policy-makers and program managers internalize their implications and make them more likely to take informed action.

Many opportunities for the development of policy/program indicators exist that have as yet been little explored. Given the importance in cities of spatial patterns, for example, one can take advantage of the fact that so much administrative byproduct information is now available with geocoding. Computer mapping of many types of information can provide powerful indicators comprehensible to the lay person, which will show the spatial patterns of change. It can be available on almost a real time basis and allow anticipation of change and a proactive rather than a reactive stance. For example the location and number of building permits and housing sales in a city can be mapped and produced on a frequent basis to help local officials to see where in the city development is occurring and to respond with services and infrastructure or changes in their investment plans. The speed of turnover of housing can be an indicator of where speculators are at work, and where low-income renters may be displaced. Business permits or sales tax revenues could provide neighborhood-based information on changes in economic and commercial activity. Such indicators can also be developed out of the experience of residents in a community, as was done in an experiment in Lancashire that looked at public perceptions of sustainability (Macnaghten, 1996).

Rapid Feedback Indicators for Individuals, Agencies and Businesses

In the final analysis a city is made up of home owners and renters, commuters, entrepreneurs, workers, service providers, taxpayers, regulators, and so on. A city is the result of what all these individuals, businesses and agencies do. A city is what they produce and reproduce over time, whether these are buildings, practices, or institutions. The physical, social and economic form of a place is the result of millions of individual actions and interactions in dynamic relation with the context of the larger society, the natural environment, and global economy. Each of the actors reacts, not only to others, but also to her perceptions of changes in the context. People in their different roles act on the information they have to try to accomplish their own missions and in the process the city evolves.

These participants in a city typically have little information to help them optimize their own welfare or do their jobs effectively. While they, like flocking birds, can look at the person or business next to them or down the street and adjust their actions accordingly, they can see little of the larger system. They cannot readily tell how it is evolving, if business conditions, for example, mean it is a good time to open a new upmarket restaurant. They cannot find out in real time where in the city they can find the goods they need at the current lowest prices or where they can find the ideal package of housing, school quality and costs for their needs. These tasks require a lot of research so most act with very limited information. If they could act in a more informed way for their own interest, complexity thinking, like classical market theory, would predict they will also make the urban system work better. If they can choose intelligently from more options, they can use their own and the city's resources with greater efficiency.

A few examples of rapid feedback indicators that improve the workings of a city as a self-organizing process are already in place. The best example (besides the weather report, which helps us decide whether to walk or ride, or whether to go to the park or a movie) is information about the location and speed of traffic on a city's freeways or the delays on public transit. Each morning in major metropolitan areas one can tune in the radio or TV to get detailed information on the location of accidents and the length of

hold-ups. This information comes in from police departments, news helicopters, and individuals with cellular phones. It is up-to-the minute and generally accurate. Thousands of people then make their decisions about routes to take. The result is that traffic spreads more widely over the system, using it more efficiently, air pollution is minimized, and individuals save both time and aggravation and thus have more energy to apply to more constructive purposes. Emerging technologies will allow us soon to improve on this by electronically counting cars as they enter freeways, measuring their speed and reporting quickly to commuters. This kind of system is likely to become increasingly important, not only to individuals, but also to business and the economy as just-in-time production puts a premium on the ability of firms to deliver goods on short notice as part of flexibly linked sectors such as high technology.

Other indicators to assist people, agencies and businesses in managing their activities are technologically within reach. In water-starved California, for example, where the cost of water is high, residents could have daily information on their water use and its cost available in their kitchens, so they can discover when they have leaks or recognize when a particular water-using practice is wasteful and expensive. Similarly, it could be made easier for a household to monitor its own daily or even hourly electricity or gas usage, so they can make more informed decisions about how and when to use these resources. Water districts that have recently installed residential meters have been able to use information on water usage to identify where water mains have been leaking and wasting a substantial percentage of the water supply. All of these rapid feedback indicators can create a system of distributed intelligence that can support a more sustainable city, without central direction or regulation.

A Caution

If indicators are to provide the distributed intelligence needed to assure that cities can be self-organizing learning systems that can be creative and sustainable, it is critical that indicators are not used in a simplistic way to argue that a policy is not working or to punish any player or agency for some presumed failure. Indicators do not show the causes of problems, only their existence. They show trends in conditions but they do not tell us what to do. They are *indicators*, not answers. They are the starting place for discussion and exploration of potential action. Their purpose is to help all of us reflect, experiment and improve. If one tries to use indicators as criteria to reward and punish cities or agencies, the result will be to undermine the entire indicator system. No agency will produce accurate data if they are going to be used for criticism and punishment. Alternatively, an indicator developed in a thoughtful, informed way by the stakeholders and agencies to help them find out about conditions and to communicate with the public and with leadership about problems, needs, and opportunities is an indicator that will continue to be produced over time because the people who produce and use it know it is valuable to them.

Recommendations for Action

There is no formula or even simple strategy to accomplish these proposals. The task will be different in each city, depending on its culture, issues, players, practices and institutions. It will be essential for each city or region to design its own indicators in its own way to serve its shared goals. While communities can learn from each other's work and ideas and they can and should use the work of experts as inputs to their

discussion, what they do has to be their own if the indicators are to help make theirs a self-organizing, adaptive system. The main ingredients of the effort are several (see Redefining Progress *et al.*, 1997). The community needs to develop a way to bring its key stakeholders, agency players, experts and citizens into a process to select a set of system indicators, perhaps three to five at most. The number must be limited to avoid information overload and because the development of each one is time-consuming and challenging if done properly. Shortcuts will simply make these measures useless. One should be prepared for this to take two or three years. Local universities can often help provide the technical knowledge in an inexpensive and politically unbiased way. It is important for the discussions to address the difficult, controversial issues because these will present the greatest opportunities for learning and change. Professional facilitation can be helpful. It will be sensible to begin by focusing on those issues and topics where a substantial amount of interest and commitment to some kind of action is already in place. This commitment can mean that the energy, interest and funding to develop the indicators will be forthcoming, and the indicators can be associated with actual proposed policy. This means they can be designed to be relevant and to get attention. Starting with such topics is more likely to help people become interested in indicators for topics not so high on the agenda.

At the same time as a community is working on system indicators the participants in a particular policy area should be gathered to identify the policy and program indicators that could help them to see how things are going, whether outcomes are good or not, to diagnose causes of problems and identify opportunities for improvement. This must include the public agencies involved in producing the good (and usually also involved in producing the data) as well as the private players who depend on the good or service, and the interest groups who pay attention to it. There will need to be funding to develop these policy/program indicators, as there will for the system indicators, because it will take time and resources to gather and tabulate data, to reorganize reporting systems and implement them. It will require staff to organize the discussions and follow up ideas. This cannot be done as part of the regular duties of already overtaxed city staff. However, when a system of policy/performance indicators is fully operational, the savings in improved performance will more than compensate for the initial start up costs. Leadership will be required to help assure that the new indicators are actually used and discussed. In particular the city elected officials, working group members and others should be introduced to the key indicators and asked to agree on the ones they want to have reported regularly to them. Workshops with staff and citizen leaders can help make sure this is not solely an internal exercise that may be ignored over time by city staff who may be resistant to change or to the greater oversight that may come with indicators.

For rapid feedback indicators the process of development need not have so much public discussion. The main task at this stage is to explore the opportunities that have become available because of new information technology and to try to get utilities, home builders and transportation agencies to incorporate feedback data in the new facilities they build and to design user friendly information that people will be motivated to notice.

This three-tier indicator system should be ultimately designed to help assure the city can be more sustainable and adaptive, that it can be an intelligent urban system. The indicators can only have these effects if they become part of everyone's understanding and therefore of their actions. The point of indicators in a complex world is to help make adjustments and to adapt actions to rapid change, to fine tune policies to fit local conditions, to identify opportunities, to become creative about new possibilities.

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Notes

1. These efforts include, for example, Sustainable Seattle (Sustainable Seattle, 1995) and the Jacksonville, Florida quality of life indicator project (Andrews, 1996; Jacksonville Community Council Inc., 1996). Local efforts are linked together across the metropolitan areas, for example The San Francisco Bay Area Alliance for Sustainable Development that includes representatives from cities in the region. In the USA the President's Council on Sustainable Development links to each region and encourages a proliferation of locally or regional driven collaborative groups. A set of international guidelines for indicator development and communication were developed as a consensus statement at a global meeting convened by the International Institute for Sustainable Development based in Winnipeg Canada which is often referred to as a touchstone for practice in the USA. This set of 'best practices' is known as the Bellagio Principles and is available as Appendix G in the Community Indicator Handbook (Redefining Progress *et al*., 1998). The Urban Institute in the USA several years ago launched the National Neighborhood Indicators Project (NNIP) to help people in cities across the USA develop indicators of neighborhood conditions and a national Community Indicators Project assists 125 projects around the country (Redefining Progress, 1998). Examples of regional indicators in California include those developed by the Sierra Business Council (http://www.sbc.org) and by Joint Venture Silicon Valley (http://www.jointventure.org).
2. *Urban Quality Indicators*, TBC publishing co. Bos 6283 Annapolis MD.
3. Exceptions include an article assessing Neighborhood Indicators Projects (Sawicki & Flynn, 1996), a report on two cases (Besleme *et al*., 1998) a brief description of projects in Colorado (Conner *et al*., 1998), a report on five programs in Washington State (Miller, 1997). See also the special issue of the *Journal of the American Planning Association*, Spring 1996.
4. Some of the better US web-based resources to learn about community indicators projects include the National Partnership for Reinventing Government report on Best Practices in performance measurement, http://www.npr.gov/initiati/; The Sustainable Communities report of the President's Council on Sustainable Development http://www.whitehouse.gov/PCSD/index.html; Redefining Progress' list of Community Indicators projects on the web http://www.rprogress.org/resources/cip/links/cips web.html; The US Department of Energy Center of Excellence for Sustainable Development, http://www.sustainable.doe.gov/; and list of top sustainable development web sites http://www.sustainable.doe.gove/hotspots.html; US EPA's web site on sustainable community http://www.epa.gov/ecocommunity/focusing on community based environmental protection and liveable communities and offering sustainable development challenge grants; and The Green Mountain Institute Resource Guide to Indicators http://www.gmied.org/irguide.html.

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