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SCALE-LINKING DESIGN FOR SYSTEMIC HEALTH: SUSTAINABLE COMMUNITIES AND CITIES IN CONTEXT

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ABSTRACT

The design of sustainable communities and cities requires conceptual frameworks for contextualization and transdisciplinary integration. The theory of complex dynamic systems provides a holistic, explanatory framework offering a participatory perspective that recognizes the fundamental interconnectedness, interdependence, and unpredictability of biological, social, economic, and ecological systems. Building on the tradition of urban planning within a regional context, to conceive the sustainable city as an emergent property of appropriate interactions and relationships within a complex, holarchically structured whole, takes contextualization further. Increased awareness of nature and culture as an interconnected complex dynamic system, and sensitivity to material and immaterial (psychological) aspects, leads to more sustainable solutions based on transdisciplinary integration. Worldviews and value systems, and ecological literacy play an important role in the creation of sustainable lifestyles, communities, cities and societies. This article suggests that complexity theory, combined with aspects of integral theory and integral ecology, when applied through design as a transdisciplinary integrator, can provide a framework and a methodology that links spatial and temporal scales across all scales of design from product design, architecture, construction ecology, community design, industrial ecology, to urban and bioregional planning. Ultimately, a sustainable city emerges from the interactions among sustainable communities of ecologically and socially literate citizens who live sustainable lifestyles.

Keywords: complexity, emergence, salutogenic design, scale-linking design, scales of design, sustainable cities, sustainable communities.

1 INTRODUCTION

Sustainability is mistakenly regarded as an end point to be reached or as a fixed state that we can work towards and achieve permanently through appropriate design. In a constantly and now rapidly changing world, sustainability will remain a moving target. The ecological processes in which all human culture and design participate, and on which humanity depends, are not only constantly changing, they are also fundamentally interconnected and unpredictable beyond a very limited spatial and temporal scale [1].

Nature and culture can be understood as expressions of the same complex dynamic process in which social, cultural, economic and ecological issues constantly interact and feedback on each other in a non-linear, multi-causal, and often time-delayed and spatially removed fashion [2]. From this dynamic, rather than static perspective, sustainability can be defined as a continuous, community-based process of learning how to meet human needs within local, regional and global limits, without jeopardizing nature's life support systems, and without disrupting the vital ecosystem services on which this and future generations depend for their continued survival.

The health and well-being of individuals, communities, cities and societies depend critically on the resilience [3] and health of ecosystems [4] and on vital ecosystems services [5] that are provided by ecological processes within the biosphere. Therefore, one overarching goal of design for sustainability should be to improve and maintain human, ecosystems, and planetary health [6]. The author suggests that sustainable design is by necessity scale-linking and salutogenic (health generating) design across all scales of the complex dynamic system that joins nature and culture, as well as global, national, regional and local scales.

Sustainable globalization, as opposed to purely economic globalization, can only be achieved through a simultaneous process of sustainable regionalization and localization. Healthy and resilient

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systems in nature, as well as culture are holarchically scale-linking. Like a healthy organism depends on healthy organs, which in turn depend on healthy cells, a healthy city or a health ecosystem depends on healthy communities of healthy and diverse individuals. Design can play a critical role in maintaining overall systemic health, by designing-in, and paying attention to, scale-linking, synergistic, and symbiotic interactions that connect individuals to their communities and the biosphere.

Design, as the expression of human intentionality through interaction and relationship, can contribute to the creation of a culture of sustainability in which people are capable and aware enough to meet human needs and live healthy, meaningful, and fulfilling lives within the ecological and social limits of their environment.

Complexity theory describes reality as a fundamentally interconnected and unpredictable process in which we participate [7, 8]. Local actions can have global consequences. Appropriate and sustainable design facilitates the emergence of health as a system-wide property across all scales from individual to planetary. Health, ecology, and design can act as scale-linking concepts that can be used to structure a process of transdisciplinary integration of multiple perspectives into more sustainable and appropriate modes of participation.

In the face of increasingly chaotic climate patterns, mass extinction, resource wars, religious conflicts, national and international inequality, and widespread ecosystems collapses, sustainability is *the* wicked problem for design in the 21st century [1]. The complex and ill-defined nature of 'wicked problems' in design was first described by Horst Rittel in the 1960s and Richard Buchanan [9] later highlighted that a central aspect of design thinking and practice is to confront such complex problems and propose solutions by envisioning future states, and conceiving of what does not yet exist.

Design can be a way to bring individual and collective visions into material existence. Design turns values, intentions, theories, and aspirations into the material expression of a particular culture. In the author's opinion, design will be at the heart of applying the wealth of knowledge generated within diverse disciplines to the creation of a more sustainable civilization. Yet, the cold and technologically focussed intellect of research science will have to be balanced by other ways of knowing. Decision-making should not be based on the advice of expert scientists and economists alone. It will have to include other epistemologies that value not only social, cultural, ethical, aesthetical and psychological (spiritual) considerations, but also the wisdom of traditional cultures with all their place-based knowledge and locally adapted practices.

Most design problems, when considered within their wider ecological, cultural and social context, reveal themselves as wicked problems that somehow affect the overall sustainability and health of the larger system in which all of us cannot be anything else but co-creative participants. From within a participatory worldview that acknowledges complexity and aims to integrate multiple perspectives, any act of design – at any of the scales of sustainable products, architecture, construction ecology, communities, industrial ecologies, cities and bioregions [10], to the goal of creating a sustainable human civilization – faces the indeterminacy and complexity of wicked problems.

Like health, sustainability itself can be understood as an emergent property of appropriate interactions and relationships among diverse participants at all scales. There is no single strategy to achieve sustainability, rather, sustainability as an emergent property begins to characterize the overall system as millions of communities the world over begin the processes of learning how to meet their needs and participate appropriately in eco-social process *at* and *across* all scales. This can be achieved only by adapting the way we meet the needs of local populations to the unique biophysical conditions of the particular place and region they inhabit, while maintaining a scale-linking awareness of planetary limits, global equity and human solidarity.

It is useful to conceptualize global sustainability and planetary health as emergent properties resulting from appropriate modes of participation and health-generating (salutogenic) design that is adapted to, and links, local, regional and global scales. Similarly, the health and sustainability of cities can be conceived of as emergent properties arising from the appropriate participation of responsible and ecologically and socially literate citizens in their neighbourhood-scale communities.

In a constantly changing environment, our design solutions have to be flexible and adaptable to changing local, regional and global conditions. Transdisciplinary problem solving thus needs to be community based and is best guided by admittedly fuzzy, integrative concepts like, ecological, synergetic, scale-linking and salutogenic design [1,6]. The transition towards a more sustainable human civilization involves widespread participation and lifestyle changes. It is therefore crucial to embrace diversity and acknowledge the valuable contributions that multiple perspectives can add to such *fuzzy design strategies* aimed at creating a culture of sustainability.

Richard Coyne [11] recently explained: 'Wicked problems persists, and are subject to redefinition and resolution in different ways over time. Wicked problems are not objectively given but their formulation already depends on the viewpoint of those presenting them. There is no ultimate test of the validity of a solution to a wicked problem. The testing of solutions takes place in some practical context, and the solutions are not easily undone' (p. 6). We face all these design challenges in the attempt to create sustainable cities and societies.

It is precisely the complexity of interrelated problems that we are facing in the intention to catalyse the transition towards a sustainable human civilization that drive the increasing need for new theoretical and integrative frameworks as well as for tools and methodologies that make the required transdisciplinary integration and collaboration possible. The author has previously described how design for human and planetary health, and design as a transdisciplinary integrator can provide a more holistic and integral approach to sustainable development [6, 12]. This article reviews the main aspects of the proposed theoretical framework and methodology, and explores how they could be applied to the design of sustainable communities and cities.

2 COMPLEXITY AND SUSTAINABILITY

Most of conventional science and the majority of contemporary design, planning, problem solving, and decision-making is conceived and created predominantly within a dualist epistemology of detached observation, based on reductionist methodologies and mechanistic explanations of functional parts irrespective of their defining context. Solutions are increasingly taken by specialists from one particular perspective, rather than considered in the wider ecological and societal context and referred to transdisciplinary design teams that integrate multiple perspectives.

The insights gained within the specialized disciplines of reductionist science are technologically very useful – and entirely valid within the limited and highly specialized perspective that defines each particular discipline – but the reality of the world in which we participate is more complex. Sustainable participation in the complex dynamic processes that unite nature and culture requires the integration of multiple perspectives into a more holistic approach to solve the wicked problems of sustainability.

The developmental biologist Brian Goodwin [13], initiator of the Masters in Holistic Science at Schumacher College in Devon and a member of the Santa Fé Institute for research into complexity, has suggested that 'a participatory approach to the life support system of the planet means that we must become more sensitive and responsive to the subtle creativity of natural processes so that we do not destroy them through our actions' (p. 9). Goodwin [14] warns: 'We have to learn to walk carefully in relation to these complex systems on which the quality of our lives depends, from microbial ecosystems to the biosphere, because we influence them although we cannot control them;' and adds: 'This knowledge is new to our western scientific mentality' (p. 27).

Murray Gell-Mann (in [15]), a Nobel laureate and co-founder of the Santa Fé Institute, explains: 'One of the most important characteristics of complex adaptive systems is that they cannot, in general, be successfully analysed by determining in advance a set of properties or aspects that are studied separately and then combining those partial approaches in an attempt to form a picture of the whole' (pp. 12–13). He emphasizes: 'Instead, it is necessary to look at the whole system, even if this means taking a crude look, and then allowing possible simplifications to emerge from the work' (p. 13).

A holistic approach to the complex challenges of sustainability embraces the unpredictability and uncontrollability of complexity by stressing the importance of contextualization, acknowledging participation, and aiming for transdisciplinary integration and synthesis. We can never be certain that we are taking the right design decisions to bring about a sustainable human civilization, but we can make holistically informed choices and stay flexible, responsive, and adaptable. Sensitivity to the unique conditions of place at various spatial and temporal scales, and the intention to maintain the overall health and resilience of the system can help to guide the process of continuous learning that will define the culture of sustainability locally and globally.

The German bio-cyberneticist Professor Frederic Vester [2] argued: 'As difficult as it may be to engage in a transdisciplinary approach to the whole system, and as little we may be used to dealing with complex occurrences – it will not pay off if we try to make our decision-making easier on ourselves by simply ignoring the complexity of the world we live in' (p. 30). Vester believed that we will only be able to use more sustainable decision-making processes and create more sustainable designs, if we acknowledge that we are 'much more entangled with the complex systems of our environment and the biosphere, than our conventional mode of linear cause and effect thinking with its method of dividing the world into categories tries to make us believe' (p. 30).

There are three root causes for the most common mistakes we commit in dealing with complex systems: (i) the reductionist and piece-meal way we use when dealing with complexity, which makes us ignore their interconnectedness and dynamism; (ii) the tendency to ignore feedback and focus on inappropriately chosen systems parameters; and (iii) inappropriately short planning horizons that leave us unaware of time-delayed feedback [2]. These mistakes are also the most common causes of unsustainable design decisions. This is why it is of critical importance to situate the design and planning of sustainable cities within a local, regional and planetary context, and to pay attention to how cities integrate into natural process on all temporal and spatial scales.

Sustainable decision-making in complex dynamic systems requires more than the *hard data* of the specialist's analysis of partial and isolated system's components; it requires transdisciplinary integration of diverse aspects and perspectives within an interdependent whole. This kind of holistic design thinking aimed at creating a culture of sustainability can be facilitated through admittedly *fuzzy design strategies* like salutogenic, symbiotic, synergistic, scale-linking, and even sacred design [1].

We need *both* the hard data and reliable research of diverse scientific perspectives *and* the creative and adaptive potential of fuzzy design strategies. We are charting a course into an uncertain and unpredictable future, where visions of sustainable communities, towns, cities, societies, as well as, political and economic systems can serve as inspirations and guiding beacons. In the participatory process of continuous adaptation to a constantly changing complex system, all design solutions have to be adaptive, flexible, and responsive to new insights and changes in systems parameters.

Insights from chaos theory, quantum theory and complexity theory suggest our participatory involvement in an interconnected system, and indicate that sustainability is not some fixed status quo which we will ever reach at one point in the future and then have assured as the new steady state. Rather, sustainability is a community-based process of learning how to participate appropriately in a constantly transforming system with interacting social, ecological, and economic processes.

Clearly an advisable strategy in such a situation is to pay attention to how our actions affect change over the short, medium, and long term, and how local decisions can have global consequences, as well as, how locally sustainable communities can offer global solutions. By shortening the feedback loops and thus feedback times within the system, it is easier to avoid large-scale disasters and to adapt to systemic changes more quickly. Scale-linking design for systemic health offers a framework within which we can consider local design decisions in a global context and create designs that *fit* their social and environmental context at a local, regional and global scale.

3 SCALE-LINKING DESIGN

For most of human prehistory and history, our designs were by necessity adapted to the specific biophysical and cultural conditions of a particular location. Our villages, towns and cities were naturally supported by and integrated into their local ecosystems. Failure to achieve this delicate and dynamic balance between nature and culture is ultimately unsustainable. The earliest written record of humanity, the Epic of Gilgamesh, tells the story of the demise of the ancient city of Ur and the Sumerian civilization due to inappropriate environmental resource management in the form of rapid deforestation and subsequent downwind desertification and salination, which turned fertile Mesopotamia into the arid ecosystems of modern day Iraq [16].

Since the onset of the Industrial Revolution and the associated proliferation of fossil fuel consuming technology, it has been possible to create human designs that are seemingly independent of the particular ecological, hydrological, and geological conditions of a particular region or ecosystem. For the past two centuries, the effects of such short-sighted and inappropriately scale-linked design were buffered by the natural resilience and health of ecosystems and the biosphere. Since the 1960s, we are increasingly confronted with the time-delayed and multi-causal effects of badly designed fossil fuel-dependent industrial societies, which are jeopardizing systemic health at all scales, from individuals, communities, ecosystems, bioregions, to the scale of the entire biosphere.

The multi-facetted crisis of unsustainability that humanity currently faces at multiple interconnected scales simultaneously is to a large extent the result of inappropriately scale-linking design decisions in the past, resulting in inappropriate structures and processes that are still culturally recreated today without being questioned and examined. Problems are still approached without sufficient awareness of their wider scale-linking context. The challenge of the sustainability transition can only be appropriately responded to through a scale-linking design approach that empowers local communities and regional governments to become active creators of a culture of sustainability. To do this effectively and rapidly enough to avoid a civilizational collapse, we need global cooperation and solidarity unprecedented in the history of humanity.

The sustainability revolution will be simultaneously local, regional *and* global; it will require changes in worldview, value systems and lifestyles; and has to be based on widespread participation, both in the form of bottom–up community engagement *and* top–down policy changes and international collaboration. With regard to our everyday life, most of us will primarily experience and take part in this sustainability transition at the scale of our local communities, cities, and bioregions. These are the scales where our individual and collective behaviour can and does make a difference, thereby driving regional transitions towards sustainability, which will ultimately result in the emergence of a sustainable human civilization.

Almost a century ago, the biologist, town planner and sociologist Sir Patrick Geddes was among the first to highlight the necessity of integrating cities into their natural region. He advocated that all design and planning decisions should be based on the integration of insights gained through a thorough survey of the biophysical and cultural conditions of the particular locality [17]. In his seminal book *Cities in Evolution*, Geddes was the first to remind the reader to think globally and act locally [18].

Lewis Mumford used Geddes' ideas in his own advocacy of a planning methodology that was sensitive to the conditions of the ecological region. He called for the creation of healthy cities that integrated nature and culture [19]. Ian L. McHarg, who was inspired by both Geddes and Mumford, can be credited with developing a robust methodology for an ecological, regional planning approach. His study was the basis for the development of the Geographic Information System (G.I.S.) software that now facilitates more location sensitive planning worldwide [20, 21].

John Tillman Lyle [22] proposed, 'We need to recognize that every ecosystem is a part – or subsystem – of a larger system and that it in turn includes a number of yet smaller subsystems. It also has necessary linkages to both the larger and the smaller units' (p. 17). In doing so, Lyle described the holarchical, after Arthur Koestler [23], structure of healthy and sustainable processes. Lyle [22] explained: 'Our range of design scales forms a hierarchy that corresponds to the concept of levels of integration in nature or in any organized system.' He believed: 'Certain principles of organization link the levels of this hierarchy and provide guidance for design at any given level' (p. 17). Lyle was one of the pioneers of scale-linking design for systemic health, which he explored in his insightful book *Design for Human Ecosystems*.

Scale-linking and scale sensitive design strategies have been promoted by a number of different researchers [10, 24, 25]. Such scale and location sensitive design practices are important aspects of appropriate bioregional resource management and planning [24, 25]. Scale-linking design describes a holarchical approach to the creation of bioregionally integrated sustainable cities [28, 29] based on the active engagement of local people through the promotion of sustainable communities and/or eco-neighbourhoods [31, 32].

Nature's design lessons suggest that healthy systems are composed of relatively self-sufficient and self-maintaining units, which contain smaller units, and are themselves contained within even larger units. In a healthy system, each subsystem has a certain degree of self-sufficiency and resilience, but boundaries are semi-permeable and there is an exchange of energy, resources, and information. The health of the holarchy of systems within systems, networks within networks, and processes within processes is an emergent property of the interactions and relationships among all participants at all scales.

While the most fundamental changes required for the creation of a sustainable human civilization will be immaterial changes of value and worldview systems, and changes in meaning and metadesign [12], in the material and technological dimension of the sustainability transition, the design of sustainable communities and cities within the wider context of sustainable bioregions will be of critical importance.

Nature's design lessons remind us that individuals, communities, cities, bioregions, nations and the international community are not isolated from each other, but are all biologically dependent on maintaining the planetary life-support system and the overall health and resilience of the larger system that contains all economic, cultural and civilizational sub-systems. This is not to say that the diversity of human worldviews, value systems and psychological states can be reduced to the material level of biology and ecology alone, but it does stress that even if our various conceptions of nature may be culturally constructed, we are biological organisms dependent on life-supporting atmospheric conditions. Any separation between nature and culture is also a social construct. Our individual identity and sense of self can only form in community with other humans and the wider community of life. How we design and take part in these communities is therefore central to the creation of a sustainable human civilization.

The scale of integrated sustainable community design is of particular importance in the local *and* global transformation towards sustainability and the restoration of systemic resilience and health. This is why grassroots-based educational impulses like the Global Ecovillage Network's initiative to

create a curriculum for *Ecovillage Design Education* are important steps in bridging the gulf between academia and society and between theory and practice. The international consortium of ecovillage design educators, Gaia Education (www.gaiaeducation.org), supports courses on five continents based on a holistic curriculum in sustainable community design which has been endorsed by the United Nations Institute of Training and Research (UNITAR) and is an official contribution to the United Nation's Decade for Education for Sustainable Development 2005–14.

Ecovillage Design Education provides citizens with the tools and knowledge to engage creatively and actively in the process of re-designing their existing communities into more sustainable rural and urban neighbourhoods. In the UK, the 'Transition Town Movement' (www.transitionculture.org) pioneered by Rob Hopkins applies the lessons learned from decades of ecovillage-based experiments in *lived sustainability* and uses the resulting tools and insights to empower existing communities to engage with the transition towards a post-fossil fuel and renewable energy-based society. The movement engages a wide diversity of citizens in the transformation of their own community and the creation of more localized systems of production and consumption with its associated strong local economies.

Sustainable cities depend on many sustainable communities or neighbourhoods within them. Sustainability as a property of a city can only emerge through co-operative, synergistic, and salutogenic interactions among neighbourhoods that try themselves to be as sustainable as possible. Just as the puzzle of a sustainable community will be made up of a wide diversity of individually sustainable lifestyles of its members, a sustainable city, bioregion, or civilization will have to be composed of a colourful and diversely adapted multitude of sustainable communities and neighbourhoods everywhere.

Jack-Todd and Todd [24] propose: 'All the components of society, including energy, power, waste treatment, transport and food growing can be decentralized, miniaturized, and integrated on a human scale.' They argue: 'On the proposed block or neighbourhood scale, parts become symbiotic to the whole and the basic social and physical functions work together. The workings are felt and understood by residents, who live with and operate the components' (p. 116).

Just like the separation between scientific disciplines, the current separation between product design, process design, industrial design, urban design, community design, architecture and planning into disparate subjects for isolated specialists is deeply anachronistic within the context of sustainability. Broadly, focussed strategies like salutogenic and scale-linking design can help in the conceptualization of more contextualized, integrated, and synergistic solutions, which are more likely to promote sustainability, health and well-being as the overall systemic goals. Such design has to be informed by transdisciplinary integration and has to be sensitive to the complex social, ecological, and cultural dynamics of an interconnected and interdependent world.

Rapid urbanization is a profoundly unsustainable trend; therefore, every effort should be made to strengthen still existing rural communities and to empower people in these communities who often follow a more environmentally sensitive pattern of locally adapted resource use that is still based on traditional culture. Nevertheless, more than half of the world's population now live in urbanized areas; we therefore desperately need to explore how to create truly sustainable cities. Girardet [29] suggests: 'Cities can adopt imaginative new approaches to transport planning and management, and to the use of urban spaces. We can dramatically improve the experience of urban living by the creation of new urban villages, reducing peoples' desire to escape from the pressures of city life' (p. 12). Cooperative interactions between sustainable, place-based, locally adapted and predominantly self-reliant neighbourhoods promote the emergence of regional, national, and global sustainability. The sustainable city has to be considered within this scale-linking context.

4 TRANSDISCIPLINARY DESIGN DIALOGUE

One of the characteristic effects of urbanization is that community ties are broken and there is a decrease in community cohesion and an increase in individualism. Cities are melting pots with a wide range of different stakeholders, professional perspectives, and cultural perspectives. New methodologies are needed to empower such a diversity of stakeholders to talk to each other, acknowledge the validity of different perspectives, and engage in cooperative action that creates win-win-win situations for all involved. Transdisciplinary and trans-stakeholder design dialogue is beginning to emerge as such a participatory methodology for sustainable development.

Due to the complexity of interconnected ecological, social, and cultural issues, transdisciplinary integration is crucial for the creation of more sustainable solutions. Solutions to complex problems need to be informed by multiple perspectives and knowledge bases [12]. Transdisciplinary integration and active citizen participation can be facilitated through community-based dialogues that involve a diverse range of local actors and stakeholders, and are aimed at creating more appropriate solutions to meet the needs of the local community within the limits and opportunities posed by the local ecosystems and bioregion.

When design is defined broadly as an expression of intentionality through interactions and relationships, it becomes apparent that all design depends critically on our worldviews and value systems, as they shape the intentions and aspirations behind our actions [6]. In this context, all intentional behaviour is a form of design and everybody is a designer. Changes in lifestyle critically depend on our worldview and value system, thus it is crucial to also consider the immaterial (psychological) dimension of the sustainability transition. Long-term sustainability depends on widespread lifestyle changes, constant learning, flexibility, and appropriate adaptation in response to a dynamically changing world. This requires the active participation of an ecologically literate citizenry [32, 33] from the level of the local community to political networks of regional, national, and international cooperation.

Lyle [22] wrote: 'Genuinely participatory processes are beginning to take place, in design if not in government, but these do not simplify or clarify design process. Rather they add layer upon layer of varied values and perceptions' (p. 264). To facilitate and catalyse the collective, community-based learning process that moves communities and their cities towards sustainability, we have to acknowledge the validity of multiple perspectives and create new ways in which diverse stakeholders and their value systems can be integrated into a process of collective and collaborative decision-making.

The author proposes that integral theory [34, 35] and integral ecology [36, 37] may offer frameworks for the integration of multiple psychological perspectives, worldviews and value systems, which could be constructively used in transdisciplinary design dialogues aimed at the creation of sustainable communities, cities, bioregions and ultimately a sustainable human civilization. Future research and publications will explore these ideas in more detail.

According to Zimmerman [36]: 'Integral Ecology (I.E.) attempts to develop effective solutions to environmental problems by identifying and coordinating interpretations of those problems, interpretations that are generated to best practices at work in the most inclusive set of perspectives.' He adds: 'I.E. assumes that competent practitioners working within a given perspective are capable of producing truth-claims that are valid within the perimeters of those perspectives. All such pertinent truth-claims must be taken into account in order to arrive at the most comprehensive understanding of any complex situation, including many environmental problems' (p. 50).

Esbjörn-Hargens [37] stresses: 'human attitudes, behaviours, institutions, and practices are generating complex environmental problems across the globe at multiple scales' (p. 35); and suggests: 'By cultivating the capacity to inhabit other perspectives and hold multiplicity, we will be able to

respond more adequately than current, less comprehensive approaches to the complex problems that currently face our bioregions' (p. 36).

Transdisciplinary design dialogue [12] based on an expanded notion of Bohmian dialogue [38] and combined with aspects of integral theory, and integral ecology could be developed into a methodology for the community-based, locally adapted re-design of our neighbourhoods and cities. Such a participatory methodology is desperately needed to engage civil society, government, business and academia as co-creators of the transition towards sustainability. Transdisciplinary design dialogue can help us to envision healthy and sustainable lifestyles, communities, cities and societies.

Whether we are employing transdisciplinary design dialogue, integral theory, integral ecology, 'ecovillage design education' or 'transition town' approaches, ultimately the community-based process of creating a culture of sustainability in the place we inhabit and the communities we participate in will be a unique and personal experience adapted to our local and regional culture and ecosystems. Theoretical frameworks, strategies, decision-making and design tools can only help us in this process, but the transition towards a sustainable human civilization will basically depend on all our individual willingness and commitment to engage in this change.

Are we as a species ready and willing to cooperate in the creation of a healthier, more meaningful, more fulfilling, and more sustainable life for all of us? Future generations depend on the answer to this question. Potentially, catastrophic global trends are pressing humanity to rise to the occasion, transcend, value, and include all difference in culture, discipline, religion, and perspective, and to cooperate in the design and creation of sustainable communities, cities, bioregions, and ultimately a sustainable human civilization!

The unprecedented crisis of humanity's current *un*sustainability has taken us to the 'edge of chaos', old structures and processes are breaking down and the system is at its most creative and responsive to change. Erwin Laszlo suggests that humanity is currently at a bifurcation point where we have to choose between total systemic collapse and the transformation into a fundamentally new worldview and global culture of sustainability [39]. The choice humanity faces at the beginning of the 21st century is quite literally between two possible futures: *Sustainability or Collapse?* [40]. If we choose the former rather than the latter option, we will need to engage in transdisciplinary design dialogue and begin to envision, design, and create a sustainable future. In this context, everyone becomes a co-designer of the culture of sustainability!

5 ENVISIONING HEALTHY AND SUSTAINABLE CITIES

Goodwin [14] explains: 'The complex systems on which our lives depend – ecological systems, communities, economic systems, our bodies – all have emergent properties, a primary one being health and well-being' (p. 27). The emergence of health and sustainability as a defining property of the sustainable city depends on appropriate interactions and relationships on all scales of the fundamentally interconnected complex system that unites nature and culture.

In a complex and interconnected world, everybody is a participant and a designer affecting humanity's collective future through the interactions and relationships s/he engages in. A sustainable city cannot exist in isolation. It depends on, and is defined by, its context and its participants. We have to engage in the transition towards sustainability primarily at the local and regional scale, and create a sustainable culture community-by-community, city-by-city and region-by-region. Ultimately, in a fundamentally interconnected and interdependent complex dynamic system, it is safe to assume that local, regional, and global sustainability are interdependent. This is why cooperation on *and* across all scales of design is a crucial element of scale-linking design for systemic health and sustainability.

In general, the wicked problem of sustainability involves the design of more sustainable lifestyles, products, and transport-, energy- and food-systems, as well as of sustainable communities, economies,

Table 1: A vision for ecological settlement design.

- A settlement of diversity
- A settlement on a human scale
- A settlement of short distances
- A settlement which uses as little space as possible
- A settlement of occupant responsibility
- An energy efficient settlement
- An emission-free settlement
- A quiet beautiful settlement
- A settlement which values water
- A predominantly waste-free settlement
- A settlement of healthy buildings
- A settlement of native species and productive plants
- A settlement of creative conflict solving
- A settlement of human values

Source: Kennedy & Kennedy [42], pp. 228–230.

industries and cities, to make ecosystems, bioregions and societies healthier and more resilient, thereby increasing the likelihood that these systems/processes will be able to sustain themselves over the long term. Collective and community-based visioning is a powerful tool for promoting sustainable development in all these sectors [41].

Professors Margrit and Declan Kennedy [42] have offered a very thoughtful, detailed, and holistic vision for the design of sustainable settlements. This vision has been informed by many years of involvement in community planning processes, both, in mainstream neighbourhoods and ecovillage-based attempts to create sustainable communities. The main principles of this vision are summarized in Table 1. Kennedy and Kennedy emphasize, 'What unites all these aspects … is that they strive for … *an optimisation of the whole*, rather than a maximisation of individual parts, and thus a new quality of housing and indeed life itself' (p. 211). Such a holistic, quality focussed, systemically optimizing approach to designing sustainable communities and cities is characteristic of scale-linking design systemic health.

As emergent properties, health and sustainability cannot be designed-in by exclusively top–down decision-making and power structures, they also require a bottom–up approach. The way to engage citizens in the necessary transition towards a culture of sustainability is through transdisciplinary and community-based design dialogues that enable people to take part in the process of envisioning a more sustainable and desirable future for themselves, their families and their communities.

All scales of design, in particular product design, industrial design, and architecture have to integrate into the design of healthy human settlements within healthy ecosystems and healthy bioregions. Biomimicry [43], 'Cradle to Cradle' design [44], ecological engineering [45], industrial ecology [46], and sustainable construction [47] offer important inspirations for how this integration can be achieved practically. At the scales of communities, the city and its neighbourhoods, and their integration into their wider bioregion, most human needs for food, shelter, clothes, education, healthcare, and community can be met once we begin to explore the synergies between existing sustainable and ecological design approaches at these scales.

Education for sustainable development has to enable people in their own communities to engage in the design and the creation of their own local culture of sustainability. If a healthy, sustainable and

Table 2: Designing for self-regulation in sustainable communities.

The scale of the economy
Community and bioregional organization, harnessing technological potentials for decentralization via a re-utilization industry, distributed energy-generation, eco-infrastructure, local money, co-operative consumption …The local scale allows direct accountability as well as general participation. New information and communication technologies can amplify these capacities like never before, especially by connecting communities into regional, continental, and global networks, but the key relationships remain the mundane interpersonal connections in the community.
Participatory democracy
Green municipalism, participatory Green City plans, community indicators and pattern-language development. The single most defining characteristic of green or post-industrial politics is that it interpenetrates every area of life and is focused on building regenerative alternatives in all those areas. …Various forms of community self-governance should in any case emerge from various economic initiatives: retrofit programs, ecological restoration projects, community gardening and community supported agriculture and so on.
A green regulatory structure
Including community design pattern languages, performance standards, product stewardship systems, product and substance bans, and other rules that encourage bioregionalism, quality and community. Market mechanisms are not a *substitute* for conscious design of the economy; rather they are an *instrument* of such a design.
Green market mechanisms
Ecological tax systems, account-money, and other community currencies, and a green financial infrastructure. These can create spaces in the economy for social and ecological purposes.
Knowledge as a regulatory force
Via resource inventories, eco-accounting, product information and labelling, and community indicators, knowledge can enable a community to realize its potential for self-reliance and greater independence and self-regulation.

Source: After Brian Milani [48], pp. 186–199.

resilient overall system depends on sustainable, self-sufficient and self-regulating communities, then it is advisable to design for self-regulation and relative self-sufficiency at the community scale, as such communities will form the building blocks of any larger sustainable system.

Brian Milani defines self-regulation as the 'use of appropriate forms of human development in their appropriate combination' and suggests that facilitating this form of self-regulation at the community scale will help to turn 'development into something actually regenerative rather than something destructive' [48]. Milani's work is yet another example of the currently emerging approach of scale-sensitive or scale-linking design for systemic health (Table 2).

A recent design competition sponsored by the International Gas Union prompted a widely transdisciplinary group that included the Australian sustainable design consultant Alan AtKisson to create a new urban design strategy, called 'RUrbanism' that aims to integrate cities into their rural environment as well as integrating traditional rural practices into the modern city. Taking a temporally and spatially scale-linking approach, the team focused on the Indian city of Panjim in the former Portuguese colony and city state Goa and created the *Goa 2100* project. The team used a detailed GIS-based mapping process, making use of GPS technology to create and organize a large amount of demographic,

Table 3: RUrbanism design principles for the *Goa 2100* project.

The three goals of the sustainability transition
1. Sufficiency and equity: well-being of all people, communities and ecosystems
2. Efficiency: minimal throughput of matter–energy–information
3. Sustainability: least impact on nature, society and future generations

Seven organizing principles for sustainability
1. Satisfying the basic human needs of all people and providing them with an equal opportunity to realize their human potential
2. Material needs should be met materially and non-material needs non-materially
3. Renewable resources should not be used faster than their regeneration rates
4. Non-renewable resources should not be used faster than their substitution by renewable resources
5. Pollution and waste should not be produced faster than the rate of absorption, recycling or transformation
6. The Precautionary principle should be applied where the 'response' time is potentially less than the 'respite' time
7. 'Free-energy' and resources should be available to enable redundancy, resilience and reproduction

Five strategies for land use management
1. Enable a long-term ecological succession from forest to cropland to city to forest
2. Design the landscape first; situate the city in the interstitial niches
3. Land use transitions governed by the demand for ecosystem services, resource potential, natural ecological succession and contiguity
4. Identify static and dynamic elements in the city, design the former, and provide a dynamic vocabulary for the latter to co-evolve with the landscape
5. Devolve governance and taxation to the lowest viable level

Six tactics to manage physical stocks and flows
1. Use less with Factor 4 technologies for supply and social limits of sufficiency and equity on demand
2. Grow your own; tapping harvestable yields as autonomously as possible
3. Build two-way networks for security: every consumer is also a producer
4. Store a lot because renewable resource yields are often diurnal and seasonal
5. Transport less over shorter distances using least life cycle cost technologies
6. Exchange using intelligent wireless networks to enable real-time trade and delivery of goods

A dynamic fractal morphology
1. Cellular structure: nuclei, cores, spines and skins
2. Hierarchical networks adapting to topography
3. Optimal densities, settlement structures and heights enabling security
4. Contiguous and hyperlinked with interpenetration of living net
5. Dynamic consolidation and nucleation around fractal boundaries and surfaces

Source: Alan AtKisson in Hargroves & Smith [49], 2005, p. 311.

socio-economic, planning, natural resource economics, energy, transportation and industrial data [49]. Table 3 summarizes the design principles that were developed for the *Goa 2100* project.

AtKisson (in [49]) reports: 'The group calculated that this system of RUrban development, if adapted to develop a network of cities and linked urban areas along India's western coast, could support

over 120 million people sustainably, providing realistic alternatives to mega-cities like Mumbai' (p. 310). 'RUrbanism involves transforming the city into a symbiotic partner with both nature and rural culture, and a net producer of resources and value, rather than a parasitic consumer' (p. 312). This design approach offers yet another example of scale-linking, synergistic, symbiotic, and salutogenic (health-generating) design.

The design principles for a RUrban sustainable development strategy listed above clearly reflect an approach of joined-up thinking informed by diverse disciplines, including ecology, chaos and systems theory, and complexity studies. This is characteristic for scale-linking design for systemic health, resilience, and sustainability.

Hugh Barton [30], the director of the 'Centre for Healthy Cities and Urban Policy' highlights the fact that a salutogenic intention, a vision of greater health and wellbeing for our communities, societies, and ecosystems, can unite multiple stakeholders into a community-based participatory process of learning how to live sustainability together, with each other and our environment. Barton argues: 'Health of our community, health of our city, health of our planet, health of our children – all have a convincing ring, and health relates very well to the reasons for reinventing neighbourhoods: local work, safety, community, equity, climate stability, clean air and water etc.' Barton concludes: 'Linking the health and the environment agenda together begins to provide a constituency of political support that can make things happen' (pp. 248–249).

An increasing amount of transdisciplinary team-based approaches to the design of sustainable communities, towns, and cities are informed by similar design principles and similar visions. Ultimately, each community and city will have to reaffirm such a vision in their own way and make it specific to their own community and city. Nevertheless, sets of general principles can help to structure and broaden the dialogue that shapes such local visions in which local people redesign their community.

6 CONCLUSION

While sustainability as an emergent property of any system ultimately depends on the appropriate participation of all participants within that system and therefore has to emerge from the bottom-up, inspired political leadership and appropriate policy choices and incentives from the top-down *do* play a critical role of enabling and empowering community-driven transformation towards a culture of sustainability. Yet again, we are moving from either-or decision-making to a more joined-up, both-and, and transdisciplinary way of making decisions.

It has been suggested here that *fuzzy design strategies* defined by the intention to engage in salutogenic, scale-linking, synergistic, and symbiotic design may prove useful in the transition towards a culture of sustainability and the creation of a sustainable human civilization. Furthermore, it was suggested that methodologies of transdisciplinary design dialogue and community-based visioning processes as well as 'ecovillage design education', the 'transition town movement' are offering some tools for participatory strategies of transformation.

Scale-linking, synergistic, salutogenic design [1, 6] can help to put the sustainable city in its context. The design of sustainable cities cannot be approached in isolation. It has to be linked to the larger and smaller biophysical scales within the holarchy of a healthy biosphere; and needs to be considered from within multiple perspectives. Sustainable design has to confront the complexity of interdependent social, cultural, economic and ecological issues. The creation of sustainable cities is an important aspect of the wicked problem of sustainability. Ultimately, sustainability requires a widespread shift in human consciousness towards an awareness of individual responsibility for how our actions affect the wider social, cultural and ecological processes in which we participate. This requires participatory processes in which re-empowered citizens are given access to insights gained from within a wide variety of perspectives, disciplines, professional practices, worldviews, and value systems. Such a process can change attitudes and life styles.

Clearly, the design of sustainable communities and sustainable cities will be the outwardly material expression of this civilizational transformation, while the psychological (spiritual) metadesign changes in worldview, value systems, meaning making, and intentionality will ultimately result in a widespread change towards more sustainable lifestyles. The creation of sustainable communities and cities has to take place within the immaterial realms of human consciousness, awareness, psychology, ethics, spirituality, and culture, as well as within the scale-linked complexity of material culture *and* nature.

'If we get things right in the coming years and decades, cities will become the beacons of a culture of sustainability.' Girardet [28] continues: 'If we decide to create sustainable cities, we need to create a cultural context for them. In the end, only a profound change in attitudes, a spiritual and ethical change, can bring the deeper transformation required' (p. 274). Scale-linking, synergistic, symbiotic, and salutogenic design, ultimately aims to maintain the natural co-dependence and co-evolution of the whole and its parts. Such design aims to strengthen the health and sustainability of the scale-linking holarchy that unites the individual with the community of life itself. From this perspective, all design for sustainability is also sacred design as it contextualizes the individual within a meaningful and mutually supportive context of a healthy and life-sustaining whole.

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