

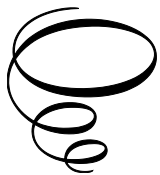
Ecological and Salutogenic Design for a Sustainable Healthy Global Society

Ecological and Salutogenic Design for a Sustainable Healthy Global Society

Edited by

Ken Yeang and Alan Dilani

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The Sustainable Development Goals (SDGs) outlined in the United Nations' vision are transforming our world through 17 goals and 169 targets, described within a thematic framework of the relationship between the planet, people, prosperity, peace, and partnerships.

Ecological and salutogenic design principles have been addressed as a recurring theme for decades but have not been well integrated into design practice and public health policies in our society. As editors of this book, we (Alan Dilani and Ken Yeang) support the United Nations' SDGs, especially Goal 3 i.e., the promotion of health and wellbeing for all. Together with several leading scientists and practitioners from around the world, we have discussed the benefits of this progressive approach to human development; it offers valuable insights for governments and the public and private sectors to seize the opportunity to develop a healthy built environment. These principles and their applications provide the foundation for a sustainable and healthy global society.

For the design profession (architects, planners, designers, etc.), concern around designing a healthy and sustainable society constitutes the most compelling task to be addressed and implemented across all sectors where human beings live, work and play. The challenge for ecological design is to provide a green context for a healthy society, dealing with built infrastructure that creates clean air, clean water, clean food, and clean land. This is achieved through water management and retention, natural heating and cooling, and renewable energy which, in turn, are necessary for human health and wellbeing. These principles are intertwined with those of salutogenic design, which supports human health in daily life.

This book contains a unique selection of papers written by some of the most respected scientists, architects, designers and practitioners, economists, and landscape planners. We appreciate and are most grateful for the efforts of all participating authors, who have shared their unique experiences, knowledge and wisdom in contributing to the enrichment of the discussion in this book. We thank architect and psychologist, Ms. Aishwarya Narayana; and Mr. Derek Parker, FAIA, former director of Anshen + Allen Architects, San Francisco, and lifetime leadership awards winner, for proofreading some of the chapters. We deeply appreciate the support of our colleagues and friends who have helped us create this book, especially our colleague and co-author, the architect Avani Parikh, from New York, for sponsoring the final proofreading of the book.

Alan Dilani, Stockholm, June 2021.

Ken Yeang, Kuala Lumpur, June 2021.

NOTE ON EDITORS



Dr. Ken Yeang, Ph.D. is an architect, planner and ecologist who is best known for his signature green architecture and master planning, differentiated from other green architects by his authentic ecology-based approach, distinctive green aesthetic, and performance beyond conventional rating systems. He is the world's leading green skyscraper architect. In the tropics, especially, high-rises are traditionally the most un-ecological of all buildings, often wasting up to 30% more energy than lower structures built with the same materials. Yeang uses walls of plants: photovoltaics, scallop-shaped sunshades, advanced ventilation, and whatever he can to collect water and breezes. The idea is to make buildings run as complete

ecosystems with little external energy supply. He is not there yet, but the possibility of the green skyscraper is developing fast, as ecological imperatives filter into the consciousness of the startlingly backward world of international architecture. He trained at the AA (Architectural Association, UK) and received his doctorate from Cambridge University (UK) on ecological design and planning. His key buildings include Solaris (Singapore), Menara Mesiniaga (Malaysia), Spire Edge Tower (India), Genome Research Building (Hong Kong), and Great Ormond Street Children's Hospital Extension (UK). He is the Principal of T. R. Hamzah & Yeang, with offices in Malaysia, UK and China. He is a recipient of the Malaysian Institute of Architects Gold Medal, the Government of Malaysia Merdeka Award, and the Architectural Society of China Liang Sicheng Award, 2016. The UK Guardian newspaper named him as one of 50 individuals who could save the planet and he was named by CNN as the leading architect in ecological design.



Professor Alan Dilani, Ph.D. is a founder of the International Academy for Design and Health (IADH) and the journal, *World Health Design*. Dr Dilani has been engaged worldwide in several universities in the field of design and health, developing "salutogenic design", in both medical and design institutions across the globe. He holds a Master of Architecture in environmental design from the Polytechnic of Turin, Italy, and a Ph.D. in health facility design from the Royal Institute of Technology, Stockholm. His research at the Karolinska Institute, Medical University, which developed a multidisciplinary research approach, led to a new design theory called salutogenic design. Dr. Dilani's design theory reflects Aaron Antonovsky's salutogenesis health theory, which posits that life's experiences

– understood as more or less comprehensible, manageable, and meaningful – shape one's sense of coherence which, in turn, helps each person to successfully mobilise resources to cope with life's stressors and manage life's tensions – leading to health. Dilani asserts that this definition of health, and the "theory of health" that underlies it, lead to a coherent design method and approach. He describes how design uninformed by salutogenic theory causes unnecessary stress, while emphasising the importance of a stress-prevention design approach to the built environment. He has brought together scientists, policy-makers, and industry experts, as well as designers and building owners from across the globe to discuss the principles and application of ecological and salutogenic design approaches, in support of sustainable development in a healthy, urban, post-corona society. Dr. Dilani was awarded in 2010 by the American Institute of Architect's Academy of Architecture for Health, for his promotion of high-quality design research.

NOTE ON CONTRIBUTORS



Gunther De Graeve

Managing Director of the Destravis Group and CEO of the International Academy for Design and Health, Gunther De Graeve is an international health architect and strategist with a reputation for delivering quality solutions for the complex issues facing health service providers. He is recognised as a thought-leader within the industry for his innovation in operational models and infrastructure solutions, his sustainable approach to planning, and for his attention to detail, promoting and enabling flexibility and future trends. He has planned, designed and/or delivered major hospital developments in Europe, Australia, and New Zealand. He values the translation of research and frequently engages in research studies which realise system improvements. Gunther is a proactive member of the health

facility community, participating in and speaking at international conferences and study tours. He actively promotes new achievements in the industry.



Richard Ashby

Dr. Ashby is one of Australia's most experienced clinician executives. He is a Senior Executive in Digital Health at the Destravis Group. For two decades, he occupied several senior health executive roles including Executive Director of Medical Services at both the Royal Brisbane and Women's Hospital and the Princess Alexandra Hospital; Executive Director of the Princess Alexandra Hospital; and Chief Executive of the Metro South Hospital and Health Service, the latter serving a population of 1.3 million with an operating budget of \$2.3 billion. In 2017, the Minister for Health appointed Dr Ashby to the position of Chief Executive of eHealth Queensland, responsible for an operating budget of over \$400 million and a capital portfolio of over 100 IT projects with a combined value of over \$1 billion.



Paul Barach, BSc, MD, MPH, Maj (ret.) is a board-certified anaesthesiologist and intensive care physician working at Jefferson College of Population Health, Philadelphia. He trained at the Massachusetts General Hospital, affiliated with Harvard Medical School. He has been involved in advising on the design of many healthcare facilities in the US, Canada, Europe and Australia. He is a passionate believer in advancing the quadruple aim, focused on patient safety, value-based care, healthcare worker support, and using fit-for-design buildings to deliver optimal healthcare. He has faculty positions at numerous universities and has been invited to consult on numerous hospital designs. He was Chair of Research at the Center for Health Design, is a board member of the International Academy for Design and Health, and a member of the US FGI.

Paul's work has led to over \$16,000,000 in federal competitive grant funding. He has published more than 300 scientific papers and five books.



Derek Parker, FAIA, RIBA, FACHA, FIADH, is an architect. He designed all kinds of healthcare facilities in 15 countries and received more than 75 awards for design, distinguished practice, and lifetime leadership achievement. He has published numerous papers and presentations on healthcare worldwide. He was a board member and the Vice-Chair of Laguna Honda Hospital Foundation, 2008-2013; and a board member of Marin General Hospital, 2010-2014. He is Co-Founder and Chair of The Medica Power Corporation, developing a technology to safely convert medical waste to energy. He is also a senior advisor for Aditazz and the Co-founder of the Center for Health Design (C4HD). He is Director Emeritus and a member of the scientific committee at the International Academy of Design and

Health in Stockholm. He is a founding member of the editorial board at Health Environments Research and Design; and was a board member of The National Academy of Engineering (2002-2008). He's a Fellow of the American Institute of Architects; and a Fellow of the American Academy of Healthcare Architects. He is a member of the Royal Institute of British Architects; and a Lifetime Fellow of the International Academy of Design & Health. He is a board member and the treasurer of the 2112 Foundation, San Francisco; and a member of the advisory board at Care for Peace, Myanmar.



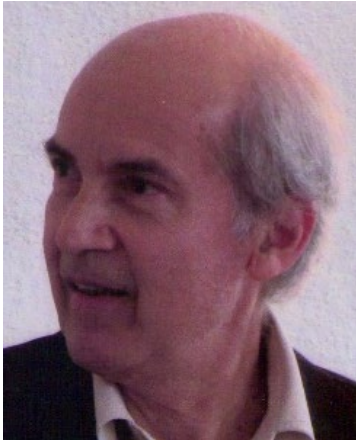
Tye S. Farrow.

A Senior Partner at Farrow Partners Architects, FRAIC, B.Arch., M.Arch.U.D., M.Neuro.Appl.Arch.Des., OAA, MAIBC, AIA Assoc, LEED AP, Tye Farrow has gained international recognition for designing places that enhance our capacity to thrive — culturally, economically, mentally, and physically. He has initiated a global “cause health” movement aimed at raising expectations for design as the basis for total health, which extends beyond environmental sustainability and physical health to encompass our mind-health, connecting the dots between neuroscience and architecture. Tye's projects across North America, Asia, Africa, and the Middle East demonstrate leadership in this visionary quest. He has been invited

to present his ideas at leading institutions, including the Mayo Clinic and the Cleveland Clinic, as well as at venues from Finland to New Zealand. His portfolio includes multiple international awards for designing some of the most technically advanced facilities in the world.


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A civil engineer and PhD in “building restoration and technological innovation”, Dr. Albatici is full Professor of Building Construction at the University of Trento, Italy. His main research interests are indoor environmental comfort; architecture and salutogenesis; zero energy and solar passive building design; and building automation. He leads research groups within several national and international projects. He is also a teacher on courses organised by professional associations and public and private bodies, concerning energy and environmental sustainability in the building sector. He is author of more than 140 publications including books, articles in scientific journals, and conference proceedings.


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Having graduated in architecture at the Politecnico di Milano, Stefano Andi is a self-employed professional at the FormaeFlusso living organic architecture studio in Milan, Italy. He studied Rudolf Steiner's architecture in depth at Alexander Tschakalow's studio in Dornach, and has taught at the Rudolf Steiner School in Milan. Since 1990 he has been the Italian representative of the International Forum of Man and Architecture (IFMA) in Amsterdam and was president of the Milanese Anthroposophical Association, 2010-2012. He is active in the field of design, teaching and disseminating themes related to the promotion of organic movement in architecture.


Mark W. Johnson

Mark Johnson is a designer for the regeneration of inner cities. He is known for complex projects involving green infrastructure as a catalyst to economic, environmental, and social change. He has received many awards for planning, design, and service. In 2016, *Curbed* magazine named his Larimer Square as "one of the 11 best streets in America," and the Canadian Institute of Planners named his St. Patrick's Island the "Greatest Public Space 2016" in Canada. Mark is a frequent lecturer at universities and other institutes on the role of urban design in public health, and he is a board member of the Van

Alen Institute in New York.

**Ihab M.K. Elzeyadi,**

Dr. Ihab Elzeyadi is an architect, building scientist, and design educator. He has been engaged in the design, construction, and research of high-performance buildings for more than 30 years. Professor Elzeyadi joined the University of Oregon from private practice where he was a senior architect and project manager at various top 10 ENR professional firms for eight years. His research and consulting focus on indoor environmental quality (IEQ) and occupant wellbeing in sustainable buildings. Dr. Elzeyadi has published more than 95 peer-reviewed papers, 8 chapters in peer-reviewed edited books, 2 books, and 1 pending US patent. Various grants and awards exceeding \$5.6 M in funding supported his research projects.

**Mardelle McCuskey Shepley**

Mardelle is a professor and Chair of the Department of Design and Environmental Analysis. She is the Associate Director of the Institute for Healthy Futures at Cornell University and serves on the graduate faculty in the Department of Architecture. A Fellow of the American Institute of Architects, she has LEED AP and EDAC credentials. Dr. Shepley has authored/co-authored six books, including *Healthcare Environments for Children & their Families*, *Health Facility Evaluation for Design Practitioners*, *Design for Pediatric and Neonatal Critical Care*, and *Design for Mental and Behavioral Health*. Dr. Shepley has worked full and part-time in professional practice for 25 years.

**Mane Mehrabyan**

While completing her undergraduate degree at Cornell University, Mané Mehrabyan discovered the importance of healing, both through the physical environment and through liberation from institutional and systemic oppression. After working as a UX researcher in a global tech company and an engaged leadership program, Mané now works in Armenia with organisations and individuals to co-facilitate and co-create workshops and programs to create more humane systems. She uses diverse methods, including those from applied theatre, storytelling, and participatory design.

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Naomi A. Sachs is Assistant Professor at the University of Maryland in the Department of Plant Science and Landscape Architecture. She is Founding Director of the Therapeutic Landscapes Network, a non-profit knowledge base and online interactive space for information about landscapes that promote health and wellbeing. She has published and presented nationally and internationally on the positive role of nature in human health. Among other publications, Naomi is co-author (with Clare Cooper Marcus) of the book, *Therapeutic Landscapes: An Evidence-Based Approach to Designing Healing Gardens and Restorative Outdoor Spaces*. She is Co-Editor of the peer-reviewed journal, *Health Environments Research & Design*.

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Kati Peditto, PhD, EDAC, is an environmental psychologist and Postdoctoral Sssociate in the Department of Design and Environmental Analysis at Cornell University. She received her PhD in Human Behavior and Design from Cornell University, where her research focuses on providing equitable health environments for vulnerable populations, including adolescents and young adults with cancer. She is the recipient of the 2018 New Investigator Award from the Center for Health Design, and a 2018 AIA-AAH Tuttle Fellow in Health Facility Planning and Design.

**Angela Lee**

As Regional Managing Director of HKS Asia Pacific, Angela Lee has 27 years of architecture and medical-planning experience for over 1.4 million square-meters of healthcare projects worldwide. She has been honoured and recognised by international institutes and publications such as AIA, Modern Healthcare, Health Facilities Management and Medical Construction and Design. Angela believes that successful design is the result of a harmonious relationship and balance between patient and user experience, form and function, budget and schedule, sustainability, and sound business principles.

**Brinda Sengupta**

With over 15 years of international design experience as an architect and urban designer, Brinda Sengupta believes the key to a successful project is great teamwork coupled with the pursuit of creativity and excellence at every step of the design process. At HKS she leads teams designing and planning healthcare environments across Asia and the Middle East, striving to integrate urban design principles into public-health strategies. Her keen interest in healthcare design, sustainability and urban design has led to numerous international publications and research projects.

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Architect, PhD, and Professor in Hospital Design and Urban Health; and Director of the Department of Architecture, Built Environment and Construction engineering (ABC) at Politecnico di Milano, Dr. Capolongo is also the coordinator of the Lab Design & Health Department ABC of Politecnico di Milano. He is President of the Urban Public Health Section of the European Public Health Association (EUPHA), and coordinator of the European chapter of the International Academy for Design and Health (IADH). He has authored several scientific publications and carries out research concerning hospital design and urban health.

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Marco Gola is an architect with a PhD in architecture, the built environment and construction engineering (DABC). He is Postdoctoral Research Fellow at the Design & Health Lab and is currently specialising in hospital design, working at the healthcare department of Techint S.p.a Engineering & Construction. He teaches on the environmental hygiene courses at Politecnico di Milano, and hospital design in various training activities for professionals and postgraduate students. In addition, he has taken part in numerous research projects related to healthcare design, the analysis of hospital performance data, hospital functional and layout design, and furniture design.

**Parul Minhas**

Parul is a research scholar in the Department of Architecture, Guru Nanak Dev University, Amritsar, India. She holds a Bachelor's degree in architecture and a Master's degree in urban design from the same institute, along with teaching experience of 8 years. Her desire to be a better parent inspired her to take up this research concerned with the holistic health of children. This exploration has opened her mind towards the interdisciplinary nature of architecture. She is deeply influenced by salutogenic design and looks forward to excelling in the same field with an intention to promote holistic health as the primary consideration for all architecture and planning interventions.

**Karamjit Singh Chahal**

Chahal is professor of Architecture at Guru Nanak Dev University, Amritsar, India. He holds B.Arch and Ph.D degrees from Guru Nanak Dev University, Amritsar, and an M.E. (Const. Tech. & Mgt) degree from Thapar University Patiala. Chahal is a life member of INTACH and fellow member of the Indian Institute of Architects. He has more than 27 years of teaching and professional experience in the field of architecture. He has authored more than fifty research papers and technical reports in various journals and for various agencies. He is actively involved in research and institutional consultancy. His area of interest is Sikh architecture and sustainability.



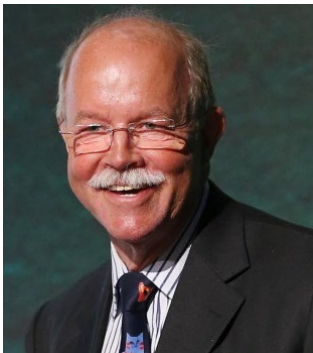
Avani Parikh

Avani Parikh is an architect and planner with 30 years of experience and a consulting practice primarily in healthcare. Having worked with LSG, New York Presbyterian Hospital, and HOK, her portfolio includes numerous health-related projects. In 1987, as a member of India's government-appointed D'Souza Committee, she formulated a new Transfer of Development Rights scheme for Bombay's Development Plan. She was Co-Chair of the AIANY Health Facilities Committee, a member of the Fit City 5 Initiative, NYSHF, and other non-profits. She is the co-author of "Choice Architecture: A New Approach to Behavior, Design, and Wellness," and the recipient of a Nautilus Book Award.



Debajyoti Pati

Dr. Debajyoti Pati is Professor and Rockwell Endowment Chair in the Department of Design, Texas Tech University. He has published over 100 articles on the interactions between healthcare, physical design, operations, people, and processes. He was twice voted among the 25 most influential people in healthcare design. He is currently serving as Chair of the Building Research Council at the National Institute of Building Sciences; and is the Director of the North America Chapter of the International Academy for Design and Health. He is on the International Advisory Board of the Swiss Center for Design and Health; and on the editorial board of the HERD Journal.



Leif Edvinsson

Professor Leif Edvinsson is a key pioneering contributor to the theory and practice of intellectual capital (IC). He was the world's first director of IC in 1991 and the world's first professor of IC at Lund University, prototyping the Skandia Future Center as a lab for organizational design in 1996. In 1998, he was awarded "Brain of the Year" by the Brain Trust, UK and listed in Who's Who in the world. An associate member of The Club of Rome, and the Co-Founder and Founding Chairman of The New Club of Paris, in 2013 he was awarded the Thought Leader Award by the European Commission, Intel, and the Peter Drucker Association. In 2017 he was awarded the KM Award at the UN in Geneva, by www.km-a.net.



Innocent Okpanum

Dr. Innocent is an architect, researcher, urban designer, healthcare design specialist, and the managing director and owner of the architectural firm, Ngonyama Okpanum & Associates, which has offices in eight cities in South Africa; Abuja, Nigeria; Accra, Ghana; and in Ho Chi Minh City, Vietnam. He studied in Genoa, Italy, where he obtained a doctorate degree in architecture. He also holds a Ph.D. in architecture for healthcare facilities design from the University of Newcastle in the United Kingdom. He has gained extensive professional experience spanning over 35 years of practice; and has designed a wide range of buildings.

INTRODUCTION AND CHAPTER SUMMARY

Theme 1: Ecological and Salutogenic Design

Chapter I: Ecological and Salutogenic Design for a Sustainable and Healthy Global Society

Ken Yeang (UK/Malaysia) and Alan Dilani (Sweden).

The authors Ken Yeang, the founder of ecological design; and Alan Dilani, the founder of salutogenic design principles, discuss the benefits of these progressive approaches to human development that have far-reaching consequences. Furthermore, they provide governments and the leaders of the public and private sectors with the opportunity to develop healthy built environments through the application of ecological and salutogenic design principles. These principles and their applications are the most important scientific domain of health promotion, setting the foundation for a sustainable and healthy society.

The authors discuss the principles and ideas for an ecological and salutogenic approach to sustainable design and the planning of our built environment, supporting the foundations of a healthy society. Several studies explicate the relationship between the design of our built environment and our health. We understand the link between access to natural light and blood pressure, between overcrowding or chronic noise and psychological stress, and the direct link between healing and nature. For the design profession (architects, planners, designers, etc.), concern around designing a sustainable and healthy future society is the most compelling task to be addressed and implemented in all sectors where human beings live, work, and play. The challenge for ecological design is to provide a green context for a healthy society dealing with built infrastructure that creates clean air, clean water, clean food, and clean land. This is achieved through water management and retention, natural heating and cooling, and renewable energy which, in turn, is necessary for human health and wellbeing. These principles are intertwined with those of salutogenic design, which support human health in daily life.

Theme 2: Salutogenic Health Systems and the Healthcare Environment

Chapter II: A Salutogenic Redesign of the Health System

Gunther De Graeve and Richard Ashby (Australia)

Hospitals and health systems globally have focused on a pathogenic (disease) approach which, in turn, has contributed to the worldwide burden of disease. In combination with inequities in the social determinants of health and wellbeing, factors such as an ageing population, significant comorbidities, and changing patient expectations are contributing to demands on healthcare services which are outstripping the supply and its affordability. The solution to these health challenges is to work towards a salutogenic health system that transforms and optimises the current system, to establish a sustainable service and infrastructure capacity that can provide equitable and safe access. The current over-reliance on acute facilities to deliver care has led to infrastructure need growing beyond what is sustainable. This is the result of infrastructure solutions being planned from historical activity and a focus on traditional models of acute care delivery. This has often led to infrastructure investment which does not meet the service need and is not able to adapt. Changes to technology, with respect to digital health, are driving changes in models of care that prioritise the long-term health of the community, focusing on out-of-hospital and preventative care. A salutogenic approach, including preventive care, has long been seen as the direction health services should take, on the basis it will be better for patients, will reduce acute health needs, and will ultimately be more

financially sustainable. Digital technologies and an alignment of patient demands are making these shifts a reality.

Chapter III: Designing Salutogenic Healthcare Facilities for Safety and Quality

Paul Barach (USA) and Derek Parker (UK/USA)

The hospitals of the future will require disruptive and opportunistic changes in culture, systems, processes, technology and behaviours. The coronavirus disruption to our day-to-day lives has provided a rare opportunity to reflect on all things health, and to reconsider what we do, how we do it, and why we do it. New buildings can help to unlock and catalyse this, but only as part of a wider vision. The hospital must address the holistic needs of patients to actively promote their recovery and agency, and better outcomes. Carers, visitors and other users also need environments that help them during what can be difficult times while facing existential threats. The needs of staff must be comprehensively met in a transparent manner, so that they too feel cared for and valued. A change in outcomes – clinical or experiential – requires a major shift in the culture of healthcare and the underpinning public discourse. Creating salutogenic environments that promote health and wellbeing and a supportive culture can help promote healing for the patient and nurture the staff, while being sustainable and equitable. Salutogenesis is now a respected and encouraged design goal. The downside is that the term ‘salutogenic’ is often overused by architects, most of whom may not know how to drive their schemes with a salutogenic methodology, and may have a tenuous grasp of the scientific underpinnings of salutogenesis.

Chapter IV: Enriched Elements of Salutogenic Environments

Tye Farrow (Canada)

A core dimension of wellness and the pursuit of holistic health is “place” and our designed environment. More specifically, the elements of our physical space. Research has confirmed that where one lives has more impact on one’s health and wellbeing than the medical system, beyond those episodes of serious disease, of course. The elements of our environments — *enriched* environments — in which we can thrive ecologically, physically, economically, culturally, and socially, can be consciously created. As a society, we can create environments that meet deeply-rooted biological, physiological, and psychological needs. We can create environments that reverse the surge of lifestyle-related diseases and alleviate the drowning of the human spirit. We can create sustainable and holistic living conditions where we can flourish and prosper, instead of merely survive. The full range of design factors that influence our total health extend beyond the state of our physical wellbeing and ecological health, to include qualities of place that affect our state of mind and thereby enrich and accelerate optimal health. The design of every public space, building, campus, community, and every home must be judged in terms of its capacity to activate optimal health. Over the past century, people have become numbed to the harmful effects of denatured, disconnected, and dismal design. Numbed as we may be, we are nonetheless affected by the design of our physical environments. The main problem of our surrounding designed environments and habitations is that they are not intentionally designed for active health promotion – to *cause health*.

Chapter V: Designing Salutogenic Spaces to Promote Health

Rossano Altabici and Stefano Andì (Italy).

At the time of writing this, a year has passed since the declaration of a global health emergency following the outbreak of the Covid-19 pandemic, triggered by the SARS-CoV-2 virus. Much has been written about the causes at one level or another, and many ideas have been put forward on how best to tackle the problem in the short term, especially through health measures, and a new organisation of society, reflected in numerous restrictions imposed by national governments. Some researchers have explored the connection between sickness and the environment, and it has been

stressed that there is a need for “transformative change, using the evidence from science to re-assess the relationship between people and nature, and to reduce global environmental changes that are caused by unsustainable consumption, and which drive biodiversity loss, climate change and pandemic emergence” [2]. It is a vision that moves towards a bio-psycho-social approach to human health, whereby attention is shifted from the diseased organ to the human being as a complete whole, not least considering the environment in which the person lives, in all senses: physical and biological, relational, psychological, social, and ecological. In this scenario, the built environment plays a role of primary importance regarding both the impact of the construction industry (environmental and economic) and pollution created by the energy management of an often outdated and power-hungry stock of buildings and, crucially, guaranteeing conditions of hygiene such as will make it possible to prevent the onset of illnesses.

Theme 3: Salutogenic Outdoor and Indoor Environments

Chapter VI: Health-Promoting Urban Design in a Post-Pandemic Society

Mark W Johnson (USA)

The design of the urban environment plays a key role in and has a great impact on the health and wellbeing of people. However, urban planning of the 19th and 20th centuries created a harmful impact on health in the US, although some Victorian ideas hold promise for sophisticated community design in pandemic times. As we retrofit our cities for the future, old and new thinking could lead to shifts in policy and planning norms to better prepare us for the future challenges of healthy urban environments. The author, as an expert in the field of urban design with decades of practice and experience worldwide, highlights the trends and issues of healthy urban design that have been developed over time. I want to urge urban policy-makers and the academic world and colleagues to pay more attention to this crucial design thinking that should be considered a foundation of a healthy society. Why does urban design matter? Most people today, at least in developed countries, pay more attention to some of the more complex relationships between personal health, public health, and urban design. Most planning professionals are aware of the dangers of over-consumption and of the damage to our health caused by polluted air, water, and soils. We could clearly see the consequences of unhealthy lifestyle choices that are often linked to urban design. However, we have become aware of a variety of environmental issues such as climate change and the impact of energy consumption, as well as the need to address sustainability in almost all of our choices.

Chapter VII: The Salutogenic Office: The Environmental Quality of Indoor Architecture and Occupant Health and Wellbeing

Ihab M. K. Elzeyadi (USA).

How does a state-of-the-art high-performance building impact indoor environmental quality, occupant comfort, productivity, health, and wellbeing? This question highlights an important, yet under-studied objective of high performance and LEED™ certified green buildings. Not only do green buildings propose a solution to combat the building industry’s energy addiction, but they also promise better indoor environmental quality and, more recently, a value proposition that they provide better health and wellbeing for their occupants. Despite the favourability of this hypothesis, most recent studies have failed to prove these linkages leading to inconclusive evidence of green building performance. This chapter presents a case study of a 36-month comparative indoor environmental quality (IEQ) assessment and a pre/post-occupancy evaluation of a new LEED™ double-platinum certified building and compares it to a traditional office complex which the LEED building employees occupied previously. The longitudinal study was conducted for 36 months, employing long-term data collection monitoring of IEQ parameters and occupant satisfaction and health in the before and after. The Space Performance Evaluation Questionnaire (SPEQ™) was administered over the 36-month study to gain further insights on the occupants’ perspectives related to their perceptions of the building’s indoor comfort, productivity and health benefits. Results show

strong relationships between green design strategies, salutogenic building practices, and occupants' health and wellbeing, proving that a well-designed salutogenic environment can provide long-term impacts on the triple bottom-line approach of people, planet, and profit.

Theme 4: Salutogenic Healthcare Design

Chapter VIII: The Role of Salutogenic Design in Mental and Medical Health-Integrated University Clinics

Mardelle McCuskey Shepley, Mane Mehrabyan, Kathryn Sandra Peditto, and Naomi A. Sachs (USA)

A university healthcare clinic is an integral part of its academic community and can contribute to the salutogenesis, or health promotion, of the students, staff and faculty in two ways: 1) through its philosophy and protocols as a contributor to the broader campus culture; and 2) through the physical environment of the clinic itself. The notion that a clinic can play a role in supporting health and wellbeing has been explored by previous researchers (e.g., Lindmark, et al., 2018; Rakel, 2008). By facilitating a sense of coherence, a renovated university health clinic can be a salutogenic resource to both students and staff. The research described here addresses a new medical and mental health-integrated university clinic facility, the design of which includes salutogenic components at both levels. In this study, researchers used interviews and surveys to evaluate the following six primary design goals, established for the clinic during programming: transparency, accessibility, privacy, integration, collaboration and welcoming. Regarding the physical environment, the new clinic addresses many of the goals suggested by previous authors (e.g., Abdelaal & Soebarto, 2019; Mazuch, 2017; Wister, 2005). According to Antonovsky (1996), the primary objective of salutogenesis is to provide a sense of coherence (SOC) through comprehensibility, manageability and meaningfulness. A study of the salutogenic model among university students suggests the importance of the college environment in affording SOC (Heiman, 2010).

Chapter IX: Healthcare Design for a Healthy Post-Pandemic Society

Angela Lee and Brinda Sengupta (USA).

In the last ten years there has been a great focus on sustainability within the building industry. Green building technologies and green materials have become the buzzwords in every project. Designing for wellness has also come to the forefront with the recent WELL accreditation but is at a relatively nascent stage for healthcare. COVID-19 and some of the other recent pandemics and natural disasters have forced us to think about health and salutogenic design in a more holistic and sustainable way. The future state of healthcare should cater to our full spectrum of needs. Health must be embedded in how we live, work and play, and go beyond the hospital or clinic. The design of healthcare environments needs to leverage technology and big data to inform design to help shape healthy behaviours and lifestyles. The vision for salutogenic design needs to build community and enhance our resilience at all scales of the urban environment. Here, we outline some of the strategies that can be adopted to achieve this vision using case studies and best practices from research and practice around the world. Architects, medical planners, and designers need to understand the impact of their design even beyond the building envelope. Healthcare buildings need to be viewed in the overall urban context, plugging into the larger urban infrastructure, and giving back to its immediate environment.

Chapter X: Finishing Materials as Health-Promoters in Healing Spaces

Stefano Capolongo and Marco Gola (Italy).

According to the World Health Organization, every year in the European Union, four million patients acquire a healthcare associated infection. The risk mainly affects patients, being more vulnerable than staff due to their precarious health conditions. Implementing control and prevention

measures is essential to mitigate an increasingly growing phenomenon. In addition to the contact between people, transmission can take place through surfaces, which play an important role in the propagation of microorganisms, but they are very often neglected with few guidelines on microbiological evaluations. In general, the analysis of the regulatory framework shows a great lack of strategies in the selection of finishes. It is clear that designers have a great responsibility in creating healthy spaces, particularly in the important part finishing materials play within healthcare facilities, although they are often considered the final application of a surface layer on the spaces. However, they should gain greater attention, especially with respect to the activities carried out within healing environments. They can influence the transmission of hospital infections; they have a strategic role in a space more hospitable for the wellbeing of users; and they can also affect indoor air quality. This chapter investigates several finishing materials and several studies taken from the scientific literature, investigating how they can be health promoters.

Theme 5: Salutogenic Learning Environments

Chapter XI: Salutogenic Design Guidelines for School Environments and Health Outcomes

Parul Minhas and Karamjit Singh Chahal (India).

"The function of protecting and developing health must rank above that of restoring it when it is impaired." Hippocrates.

Schools are known to be temples of knowledge and places of learning but the fact that children spend most of their waking hours in school makes these environments much more significant than they may at first seem. According to C.K. Tanner, most people believe that school buildings are just big boxes in which learning occurs and they are places to store students until they drop out or graduate. Current approaches to school design focus either on aesthetics or on the academic achievement of children, often ignoring the health-promoting aspects of the built environment. A salutogenic approach to school design aims to protect and promote the holistic health of children by considering the physical, mental, emotional, and spiritual aspects of children's health. This chapter not only explores the relationship between the built school environment and the holistic health of children, but also proposes a set of salutogenic guidelines for the design of school environments to achieve the desired health outcomes. The inter-disciplinary nature of salutogenic theory integrating architecture, neuroscience and psychology imparts the much-needed complexity to conceptualise and design school environments.

Theme 6: Choice Architecture and Salutogenic Value for Society

Chapter XII: Choice Architecture and Salutogenesis

Avani Parikh and Debajyoti Pati (USA).

The mainstream theoretical approach to choice in consumer economics since the 18th century has been rational choice based on costs and benefits. But, as it turns out, people do not always choose rationally. The foundations of a broader behavioural approach to human decision-making were laid by Amos Tversky and Daniel Kahneman in the 1970s, for which the latter won the Nobel Prize in Economics. Rational choice sometimes involves deliberation — an explicit analysis of net benefits — and is context-free, whereas behavioural choice is often spontaneous and contextual. In some situations, the former appropriately describes a person's decisions regarding behaviour and action and, in others, the latter appropriately describes the response. In fact, it could be argued that other than major life decisions, very few conscious human choices follow a rational cost-benefit analysis. It is the unique strength of choice architecture to extend both sets of ideas to architectural decision-making. Choice architecture offers a tool that is measurable, cost-effective, addresses multiple issues, and is flexible. It reduces the function/outcome gap between the ideal and the actual built. Salutogenic design principles can be used to position choices to end-users that potentially create the

conditions in which people want to voluntarily adopt health-promoting behaviour-change in a variety of social and cultural settings.

Chapter XIII: The Impact of Design on Intellectual Capital (IC) and Society 5.0: Creating an ‘Aha’

Leif Edvinsson (Sweden).

Many years ago, on my way home after a long workday at Skandia Future Center, I realised and got an *AHA*. I was full of energy and spirit! How had this happened after so many hours of work and at the end of the day? The workplace had provided me with energy, rather than having drained it. What an impact! How? Was this the impact of salutogenic design? Where and How do we Learn to think of work design? One of my key learning aspects as a student at Berkeley University was to ‘learn to think.’ The Skandia Future Center in Stockholm was designed to be a workspace for ‘futurising.’ A space for organizational design prototyping. It opened in May 1996 as the world’s first future centre. It was located in an old wooden house in the archipelago outside of Stockholm. Initially full of high-tech devices, these were gradually supplemented by older antiques, such as old mechanical typewriters. Old tech was impacting the mind rhythms positively, versus the fascination of high tech. How do we nourish salutogenic architecture and design for wise spaces? The very first step might be a deeper understanding of the above-mentioned ‘Aha,’ followed by extended cross-disciplinary dialogues for long-term holistic sustainability understanding. It is multidisciplinary design, from soft to hard, from object to relationship, from economics to neuroscience. The impact is, among others, in the monetizing of the multiplier effect, but is much more multi-dimensional. The salutogenic design approach should be considered as important intellectual capital in our cities and society. In the city, it creates landmarks as intellectual capital, helping to create mind maps and easy navigation, to improve the quality of life by reducing stress and promoting health and wellbeing.

Theme 7: Implementing Salutogenic Design in Africa

Chapter XIV: Salutogenesis Philosophy and its Influence on a Post-Covid-19 Era in Africa

Innocent Okpanum (South Africa/ Nigeria).

The aim of this article is to assess the role of salutogenesis philosophy in the development and provision of the physical built environment and, more specifically, to assess its role in the design of buildings in Africa. Further, recommendations can be made for improving design and project development processes. The basic assumption of this chapter is the use of salutogenesis design philosophy to improve the design of the physical built environment in Africa, which is essential to the achievement of “the right to health” for all as recognised in the Universal Declaration of Human Rights and several international human rights instruments, covenants, and consensus documents. Moreover, most state governments in Africa have committed, to varying degrees, to implementing the “right to health,” including the right to access healthy lifestyle, goods and services, as provided for in their respective constitutions. The current public health emergency due to COVID-19 offers a great opportunity to change project implementation processes in Africa based on salutogenesis philosophy. The Salutogenesis perspective is a research-based project design approach that requires the development and introduction of an appropriate continuous evaluation, and monitoring tools to be used during design, construction, and operation. This process is essential to ensure that the physical built environment vision and objectives are fully met.

THEME 1:

ECOLOGICAL AND SALUTOGENIC DESIGN

CHAPTER I

ECOLOGICAL AND SALUTOGENIC DESIGN FOR A SUSTAINABLE AND HEALTHY GLOBAL SOCIETY

KEN YEANG AND ALAN DILANI

The authors discuss the principles and ideas for an ecological and salutogenic approach to the sustainable design and planning of our built environment in order to support the foundations of a healthy society. Several studies explicate the relationship between the design of our built environment and our health. We understand the link between access to natural light and blood pressure; between overcrowding or chronic noise and psychological stress; and the direct link between healing and nature. For the design profession (architects, planners, designers, etc.), concerns around designing a sustainable healthy society for the future is the most compelling task to be addressed and implemented in all sectors where human beings live, work, and play. The challenge for ecological design is to provide a green context for a healthy society, dealing with built infrastructure that creates clean air, clean water, clean food, and clean land. This is achieved through water management and retention, natural heating and cooling, as well as renewable energy which, in turn, is necessary for human health and wellbeing. These principles are intertwined with those of salutogenic design, which support human health in daily life.

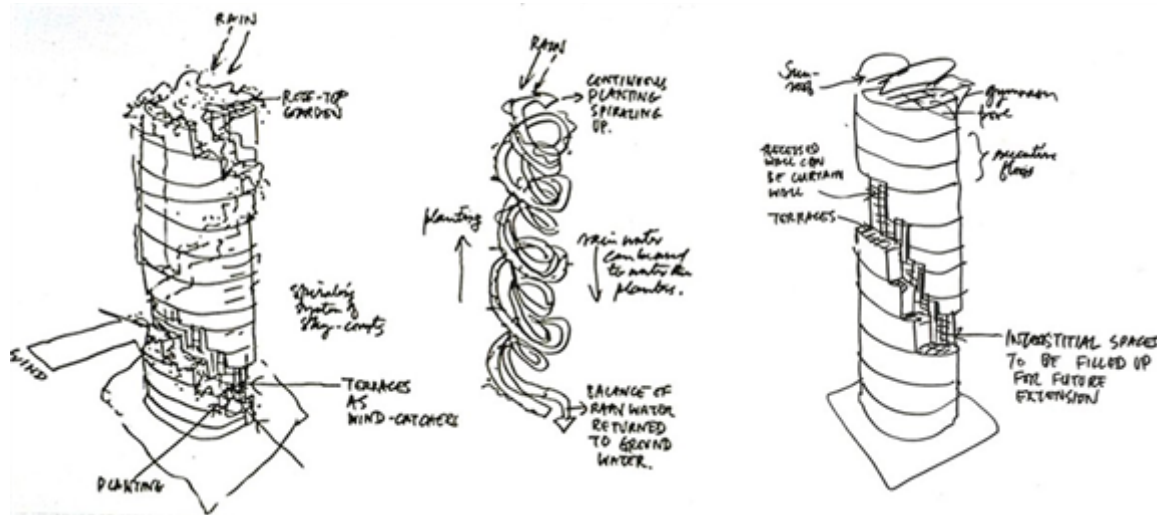
Ken Yeang, who is the founder of ecological design, and Alan Dilani, the founder of salutogenic design principles, here discuss the benefits of these progressive approaches to human development. Furthermore, they provide governments, public and private sector leaders with the opportunity to develop a healthy built environment through the application of ecological and salutogenic design principles. These principles and their applications are currently the most important scientific domain for promoting health and they set the foundation for a sustainable and healthy society.

Introduction

In 1997, the World Health Organization identified “the health arena,” which includes the priority settings and frequently-used spaces such as the workplace, schools, hospitals, correctional institutions, commercial offices, and public spaces within our towns, cities, and homes which should be at the centre of health promotion activities in the 21st century. During the 66th meeting of the General Assembly of the United Nations in September 2011, the socio-economic challenge of non-communicable diseases was discussed for the first time. The authors argue that the built environment has a significant impact on human health and are committed to bringing this understanding to design and health professions, in order to reduce the prevalence of lifestyle diseases, which constitute significant health problems in societies around the world.

Growing awareness of the importance of health promotion and the need to invest in healthy and sustainable public, social, institutional, and domestic infrastructure, through the application of ecological and salutogenic design, is at the forefront of this opportunity and will lead change in our society. Embracing ecodesign and salutogenic approaches to the built environment, infrastructure investment, and the development embedded at the core of a preventative care strategy changes the focus from risk factors and the treatment of disease to a more holistic understanding of a healthy society. Research on ecodesign and salutogenic direction highlights the impact of design factors when it comes to inspiring the designer and planner to help build a healthier society.

We are all too aware of the numerous pressing global social issues that need to be addressed. These include abject poverty, the provision of clean water and adequate food, and proper sanitation to name just a few. However, ultimately, if we do not have a clean environment comprising of clean air, clean water, and clean land, then the other pressing issues become even more difficult and expensive to resolve. Thus, saving our environment has to be the most vital cause that humankind must address today.



For the designer, the compelling question is: how do we design for a sustainable future? We need to imagine and envision what such architecture might be. How will it look if it is to be sustainable? We must address these questions while seeking to understand and address designing for the environmental consequences of architecture's functions and processes. By finding new models for design, seeking new construction and production systems, materials and processes, what action must we take to realise this vision through comprehensive and ecologically benign strategies?

Globally, businesses and industries face similar concerns in terms of understanding the environmental consequences of their functions and processes, especially with changing business models, new production systems, materials, and processes.

Environmental challenges such as climate change and other impairments within natural ecosystems are also architectural problems, given the bulk of building emissions and waste in landfills. Green architecture becomes an opportunity for architects as a community of professionals to help the world with its problems and a chance to cease creating new problems. Green design must become the core value to architecture, changing the way we design, but how should we shape our future environments to respond to the new demands of society?

We are living in a post-industrial age, in the knowledge (or Google) society. Therefore, architecture should provide positive stimuli to promote creativity. This requires a new way of looking at the role of the built environment within the context of health and wellbeing. This is called salutogenic design. Salutogenic design highlights the impact of design factors on inspiring designers and planners to help create a healthy society by developing urban design that stimulates healthy behaviour, the promotion of health, and the prevention of diseases. Considering a salutogenic design approach also means favouring social innovation. Ecological design with salutogenic design requires an interdisciplinary application of psychosocial design factors within architectural design, in order to promote a healthy lifestyle. To reduce the global burden of disease in an efficient way, major investment needs to be made in the promotion of healthy lifestyles and the development of healthy spaces.



Full height atrium with connecting bridges

Photography credit : Albert Lim

Research has shown that well-designed and people-friendly spaces encourage walking, cycling and the use of public transport. High levels of greenery also encourage physical activity which lowers blood pressure, decreases the risk of heart disease, stroke and diabetes, and prevents falls in the elderly. Evidence also shows that attractive and open public spaces reduce mental fatigue and stress. Such factors contribute to the reduction of the burden of disease which may eventually reduce the costs of healthcare.

“Global health means making major investments in the promotion of healthy lifestyles and the development of healthy spaces to reduce the burden of disease” (*Julio Frenk*, the former Minister of Health, Mexico, and the Dean of Public Health at Harvard University, talking to *Alan Dilani* in an interview for *World Health Design*, October 2010).

Promoting a healthy lifestyle and healthy spaces depends on ecological design that primarily deals with infrastructure by creating clean air, clean water, clean food and clean land. This is achieved through water management and retention, natural heating and cooling, and renewable energy, which are necessary for human health. These principles are intertwined with those of salutogenic design, which supports good human health in everyday life. Improving population health as the foundation for social and economic development will be achieved through salutogenic and ecological design principles: salutogenic design can provide social organisation, structure, and function in society; while ecological design can work to continually restore the natural environment.

Largely informed by the global recognition of the urgency of the need to reshape our built environment to tackle the 21st century challenges of chronic and non-communicable diseases, we have synthesized nearly two decades of dialogue and interdisciplinary research for design. While significant progress has been achieved to understand the value of salutogenic and eco-design, there are still some inadequacies when it comes to their implementation. One of the most pressing areas

is the rehabilitation of our existing cities into eco-cities. We need the new generation of designers, architects, and engineers to learn how to apply ecological and salutogenic design principles in their work. In the meantime, we also need the support of governments around the world to understand the value of healthy and sustainable societies.

The world needs a new paradigm with ecological design in interaction with the built and natural environments, where buildings are not add-ons to the ecosystem, but an active part of it. According to Yeang, the relationship between an ideal building and its environment is that of a prosthetic device and a person wearing it; only if the device is completely in harmony with the body will it function optimally and, in the same way, nature can be considered as the “host organism” to man-made infrastructure, with the same level of bio-integration required if the whole system is to succeed.

What is Green Design?

Green design must be an integral part of human life. Human beings are the most powerful species in nature, with the immense ability to use non-renewable resources to radically change landscapes. This affects the global climate and has resulted in the large-scale destruction of natural habitats along with the extensive loss of biodiversity. We must start by reducing the demands made by humans on the environment and natural resources, and reduce the exorbitant levels of consumption and move away from society’s present consumer culture. We must eliminate such a wasteful way of life and ameliorate the overly extravagant standards of living and comfort.

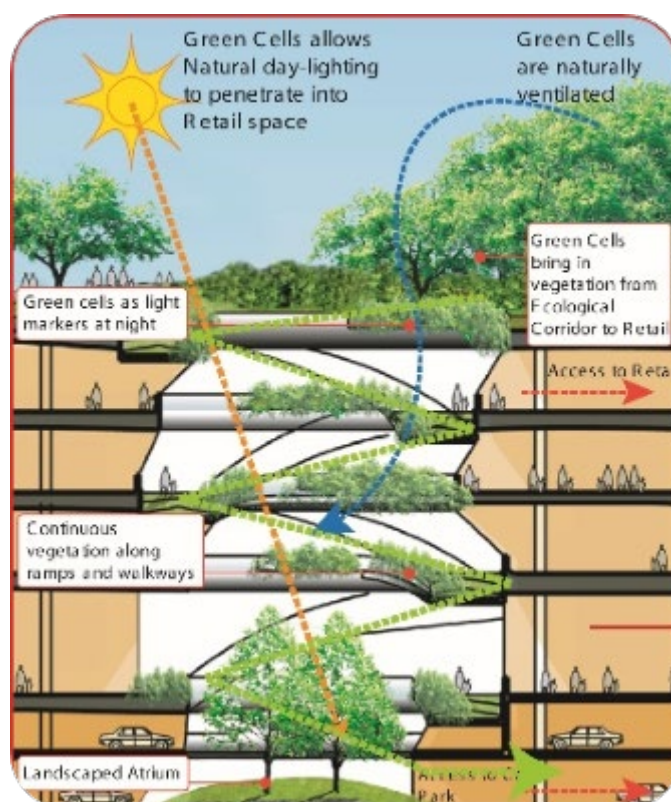


Figure 3: Eco cell brings light and ventilation into deep spaces

Our world has to change its existing polluting industries, unsustainable economies, commerce, and methods of production. We must also change our behaviour towards the natural environment to become more sustainable. Essentially, we need to radically change how we live, build, behave, work, make, eat, learn, buy, and move about. All of this falls within a building’s utility and extended function. The less we need, the less we build, and the less we’ll exploit the environment (see ‘red eco-infrastructure’ below).

Green design isn't just simply about engineering. Engineering systems, whether eco-engineering or clean tech engineering, are important components of green design (see 'grey eco-infrastructure' below), providing expediency in supporting society's habitation, environmental enclosure and comfort, as well as other desires that make our lives enjoyable.

While engineering technologies are rapidly advancing towards ever greener and cleaner solutions for our built environment, it must be clear that eco-engineering is not the only consideration in green design. Neither is green design just about rating and accreditation systems such as LEED, BREEAM, carbon profiling, etc. These are certainly useful checklists and guidelines but, again, these are not ecologically comprehensive. They are useful as a partial list of reminders and are some of the key items to be considered in green design. They are also useful for comparing buildings and master plans by a common standard and have been helpful in proselytizing green design to a wider audience. But by not being comprehensive and ecologically holistic (a crucial aspect of eco-design), many designers (after achieving the highest level of ratings such as platinum) then ask, what next? Where do we go from here? And how do we go beyond accreditation?

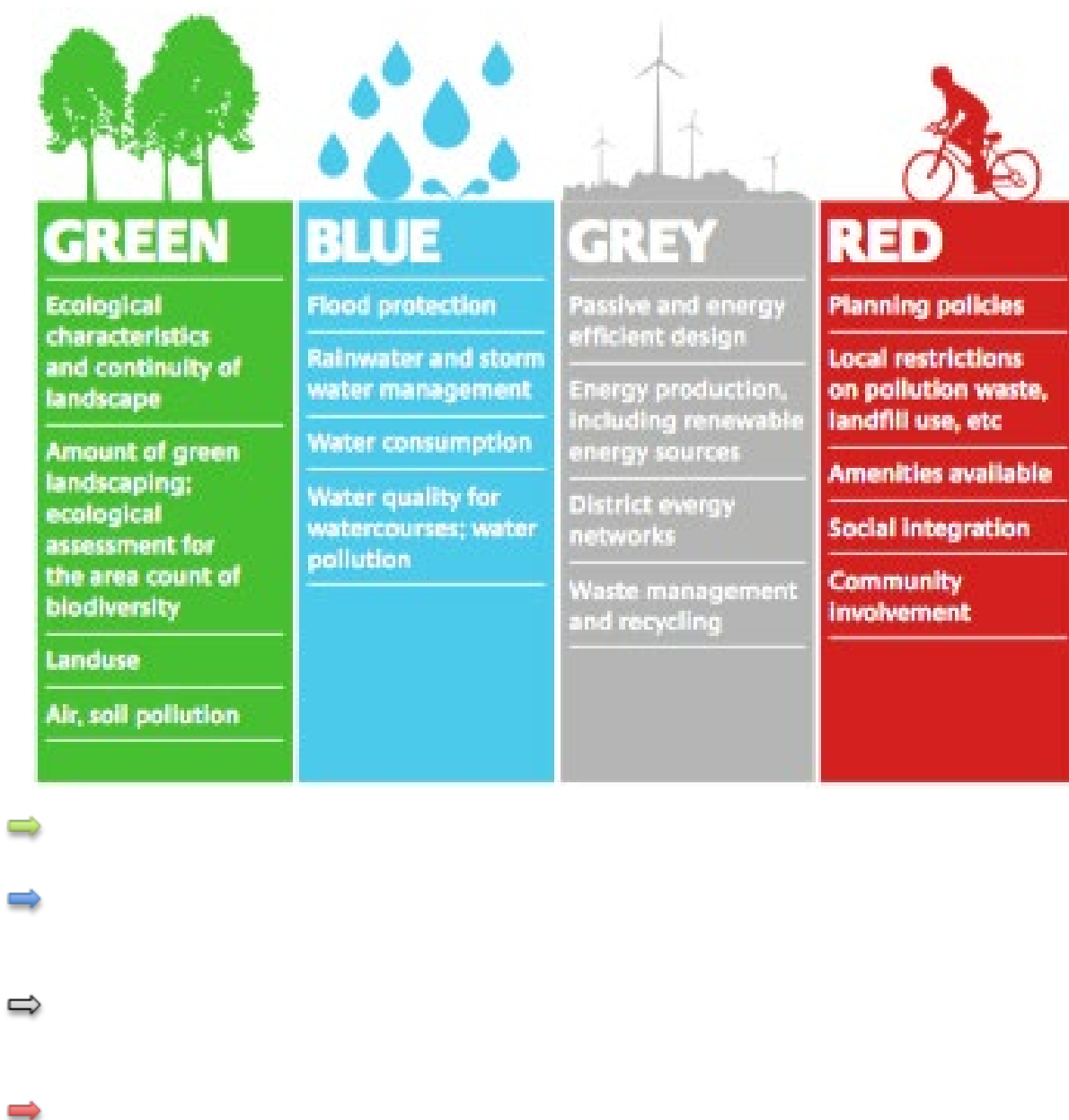
Clearly, green design has now entered the mainstream of architecture. Virtually every architect, planner, and designer today lays claim over their calling towards green design. However, some are greener by a greater margin of authenticity than others. In effect, there are 'shades of green' in design but the public is unable to tell the difference. For example, the architect who puts extensive solar photovoltaic collectors on his building would claim that it is green architecture. Architects who have achieved a high green accreditation rating, such as LEED platinum, would conclude that they have reached the pinnacle of green design. Today, many have begun to question whether achieving ratings is all there is to green design.

The contention here is that achieving complete green design is much more than the above; that green design is not as easy as it had been contended and that it is complex; that our sphere of knowledge must increase; that green design has to be the core underlying all our design endeavours for which we need new methods and design models.

Design Strategy for Eco-Design

While still incomplete, described here are four design strategies that can be adopted in combination to arrive as close as we can towards the goal of achieving equilibrium between the built and natural environment.

1) The first design strategy is to view green design in terms of the bio-integration of four essential strands of eco-infrastructures, which are colour-coded here as follows:



Green design is the continual combination of all four of these sets of eco-infrastructures into a system, as a 'constructed ecosystem'. This concept provides a flexible platform for green design. Like the factors in DNA (by Crick and Watson) which reduce a complex concept into four simple sets of instructions, these four sets of eco-infrastructures and their integration provide a comprehensive base for green design and planning (i.e., being the blending of these four sets of infrastructures into a cohesive system).

➡ Green Eco-Infrastructure

Green eco-infrastructure is vital to every design and master plan. It parallels the usual grey urban infrastructure of roads, drainage systems, and utilities. This green eco-infrastructure is nature's utilities and common services. These are the interconnected networks of natural areas and other open green spaces within the biome that conserve the natural ecosystem's values, clean air, and water. It also enables the area to flourish as a natural habitat for a wide range of wildlife, as well as delivering a wide array of benefits to humans and the natural world alike. This green eco-infrastructure is nature's functioning infrastructure (equivalent to our human-made engineering infrastructure and utilities, designated here as grey, blue, and red eco-infrastructures). In addition to providing cleaner

water and enhancing water supplies, it can also result in some instances, if not all, in the following outcomes: cleaner air; a reduction in the heat-island effect in urban areas; a moderation in the impact of climate change; increased energy efficiency; the protection of source water; other potential benefits.

Incorporating a green eco-infrastructure into a systematic way is thus vital to any design and eco master planning endeavour. Without it, no matter how clever or advanced the eco-engineering systems, the design or the master plan remains simply a work of inorganic engineering. They can neither be deemed ecological architecture/master plans nor an eco-city, in the case of larger developments.

These linear flora and fauna corridors connect existing green spaces and larger green areas within the locality to the landscape of the hinterland, and can create new larger habitats in their own right. They may even take the form of new links amongst existing woodland belts or wetlands, or existing landscape features, such as overgrown railway lines, hedges and waterways. Any new green infrastructure must clearly also complement and enhance the natural functions of what is already present in the landscape.

In the master planning process, the designer identifies existing green corridors, routes, and green areas, and possibly new routes and linkages for creating connections in the landscape. It is at this point that additional green functional landscape elements or zones can also be integrated by, for example, linking to existing waterways that provide ecological services, such as drainage to attenuate flooding.

This green eco-infrastructure takes precedence over the engineering eco-infrastructure in the design and master plan. By creating, improving and rehabilitating the ecological connectivity of the immediate environment, the eco-infrastructure turns human intervention in the landscape from a negative into a positive act. Its environmental benefits and values are as a green armature and framework for natural systems and functions — elements that are ecologically fundamental to the viability of the local flora, fauna, and their habitats, healthy soils, water, and air. It reverses the fragmentation of natural habitats (because of urban sprawl and transportation routes, etc.) and encourages biodiversity to bloom, restoring functioning ecosystems while providing the fabric for sustainable living, alongside safeguarding and enhancing natural features.

This endeavour by design to connect the landscape must extend to shape buildings both horizontally and vertically. An obvious demonstration of horizontal connectivity is the provision of ecological corridors and links in regional and local planning that are crucial for making urban patterns more biologically viable. Connectivity over impervious surfaces and roads can be achieved by using ecological bridges, undercrofts, and ramps. Besides improved horizontal connectivity and ecological nexus, vertical connectivity within buildings is also necessary, as most buildings are multi-storey. Design must extend the ecological corridors vertically, with the eco-infrastructure traversing a building from the foundations and landscape at the ground to create habitats on the walls, terraces, and rooftops.



Blue Eco-Infrastructure

The eco-infrastructure that parallels green ecological infrastructure is water infrastructure (the blue eco-infrastructure), where we need to manage the water cycle to ‘close the loop’ as much as possible, although this is not always possible with evaporation, in locations with low rainfall, and wastage, etc. Rainfall needs to be harvested and grey water needs to be treated, reused, and recycled. Surface water from rain needs to be retained within the site to be returned to the land for recharging groundwater and aquifers by means of filtration beds, pervious roadways, as well as built surfaces, retention ponds and bioswales. Water reused within the built environment (both grey and black water) should be treated using natural and sustainable processes.