Building Assessment Systems
Reversing Environmental Impacts

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The uptake and ranking levels of building rating schemes and assessment tools are rapidly expanding.[1] However, despite this impressive growth, they are still used in only a small portion of buildings, and promote 'best practice' - not sustainable design. These tools each have their value but share many problems, as outlined below. Among these are that even the ones that purport to assist sustainable design are largely reductionist and retrospective; that is, they predict impacts of existing or contemplated designs (often without 3rd party verification) and emphasise accounting processes over design thinking. Whereas most assessment tools seek improvements over standard buildings, ecologically sustainable development would require buildings that improve human and environmental health by reversing the impacts of existing development. This paper reviews some of the conceptual and practical problems of conventional assessment tools, summarised in Box 2, and proposes an approach most suited to the vast majority of buildings (eg small to medium scale commercial and residential developments outside central business) and the realities of local government development assessment staff resources. It offers an expedited alternative (or supplement, in the case of larger developments) that makes accounting subsidiary to accountability, and prediction subsidiary to performance. It is part of a larger research agenda aimed at rethinking environmental design.

Introduction

Elsewhere, it was argued that buildings can *reverse* environmental impacts, and can even have net positive impacts over the whole life cycle - and beyond [See *Design Paradigm*]. However, this would require integrating the space and conditions for ecosystem services in the urban and building fabric. This goes beyond the idea of designing buildings on the model of ecosystems, an approach which replaces natural systems with physical/mechanical structures. An assessment system is proposed which would support a paradigm shift towards design that increases natural capital, ecosystem services and urban biodiversity, and avoids irreversible land use decisions through adaptable and 'reversible' development forms. General ecological criteria that an assessment system should encourage are listed in Box 1. Other criteria are provided elsewhere [See *Design Method*].

Box 1: Ecological design criteria for eco-development

- exceed 'resource autonomy' (ie self-sufficient energy production, water and waste treatment) to actively restore the indigenous ecology - as we already exceed carrying capacity;
- integrate and increase 'ecosystem services' with development (ie provide conditions and space for the production of healthy air, water, soils through natural systems);
- foster natural habitats and 'biodiversity' (ie variety of suitable symbiotic species and ecosystems) in urban as well as regional areas;

[1] There are many dozens of assessment and rating tools. For reference, the following systems are summarised briefly by Breen [*See Assessment System Summary*]: NABERS (Australia), Green Star (Australia), BASIX Building Sustainability Index (NSW), ABGR Australian Building Greenhouse Rating (Australia), NatHERS/Accurate (Australia), EcoSpecifier (Australia), GBTool (international), BREEAM (UK), LEED (USA), ATHENA (Canada), BEES (USA).

- reduce land coverage while increasing natural capital (renewable energy, ecosystems and biodiversity);
- replace fossil with 'solar resources' (ie wind, sun, biobased materials).

Existing building assessment tools do little to support these 'positive' design criteria, partly because design for ecosystem services (to reverse environmental impacts) is a foreign concept. These tools were developed within the dominant environmental management paradigm that holds all development has negative impacts. This assumption encourages design processes that lead to 'trade offs', rather than innovations that create synergistic (win-win-win) solutions. Most assessment tools require developers/designers to invest human and financial resources in the non-creative activity of measuring the predicted damage of a proposal relative to other buildings. Interactive, outcomes-oriented tools, methods and processes are needed that stimulate whole systems thinking, synthesis and symbiosis.

While many of these tools apply a 'whole of life cycle' accounting framework, they structure an analytical process that is essentially retrospective, reductionist, data-intensive, aggregative and sequential. Creativity can still occur through iterative, incremental, accountancy-oriented activities - but it is less likely: it is even more unlikely that basic assumptions will be challenged in the process. Designers should be encouraged to think about possibilities - not impossibilities like estimating the predicted damage of a project in a complex system. By moving the finish line closer to the starting block we won't really go any faster, we just lower our standards. The question should be: "what is preventing development from achieving a Sustainability Standard, and what can be done about it" - not how 'less bad' a project is from the norm.

Design should be rewarded for increasing social, natural, and economic capital and improving human and environmental health (ie for doing more good, not less harm). Whereas designers used to be regarded as synthesisers that understood key relationships in the big picture, modern architecture has seen a gradual devolution of responsibility to other professions, such as project managers and now, assessors. To front load the design process, and empower designers while making them more accountable, designers would be required to report on what design alternatives and innovations were examined, and/or why they were not employed. This would lead to the inclusion of designers in critical decisions, and require them to demonstrate their awareness of available ecological design concepts and innovations - rather than their capacity to outsource the exercise to bean counters. The emphasis would thus shift to stimulating design thinking instead of measuring impacts after the basic design decisions are made.

Box 2: Conventional 'green' building assessment tools prioritise:

1. Retrospective analysis over future-oriented design: The analysis of the predicted impacts of a proposed design can reinforce old forms and patterns at the expense of forward-looking processes that seek to design better futures.

2. Impact reduction over impact reversal oriented: The assumption that negative impacts are inevitable can be at the expense of eco-innovations that seek to improve whole systems conditions through impact reversal.

3. Building on templates over changing underlying systems: Tools that encourage modifications to the conventional building envelope and materials come at the expense of methods that encourage the redesign of basic infrastructure, spaces and form

4. Universal engineering over natural systems solutions: The perceived need to reduce everything to numbers leads to mechanistic (ie measurable) approaches at the expense of using natural systems that defy simplistic measure.

5. Aggregating impacts over systems mapping: Analysis that aggregates measurements can obscure total resource flows and the potential for whole systems efficiencies to positively affect their context through synergies and symbioses.

6. Sequential and segmented over integrated processes: Focus on inputs and outputs of separate stages during the construction process can encourage sub-optimal changes at the expense of rationalising the whole supply chain.

7. Data-driven indicators over mapping processes: Overvaluing factors we have data for comes at the expense of mapping systems dynamics and resource flows to generate positive ripple effects throughout the system.

8. Reductionist accounting over design reporting: Reductionist analysis can lead to trade-offs between positive and negative factors at the expense of holistic design processes that seek win-win-win solutions.

9. Individual project over contextual perspective: The focus on measuring the efficiency of individual buildings and their components can be at the expense of rethinking buildings in relation to their ecological and regional context.

10. Fossil fuel reduction over shift to solar resources: The focus on what is easily measured (eg reduction energy) comes at the expense of changing to systems using healthier energy sources (eg passive solar design versus fossil energy).

10. Reducing space over value adding space: False efficiency through the minimalisation and zoning of space in design comes at the expense of optimising spatial resources by simultaneously increasing social, natural and economic capital.

1. Retrospective analysis v future-oriented design

Why does sustainability require tools for future-oriented design?

Sustainability is not a technical problem; it is design problem. Next to the military, the design of development is arguably the biggest contributor to the increasing rate of resource consumption, waste and pollution. We do not need accountants to tell us how much further we can go in the wrong direction before we hit the wall; we need to reverse direction. Social change is also important, but because poor systems design is *inbuilt*, simply improving consumer behaviour will never be enough to sustain our threatened life support systems. A sustainable future requires systems re-design to align our human-designed systems of development (buildings, institutions, policy, etc) with ecological systems. Our standard building assessment tools reflect this failure to recognise the need to reverse ecological decline through design. They are not 'design-based' (ie future oriented), but rather 'accountancy-based' (retrospective). The emphasis on predicting the negative impacts of a proposed design has eclipsed creative processes that could instead be directed at generating basic design alternatives and solutions.

Just what is meant by design-based tools, as opposed to accountancy-based, tools?

Design is a holistic, future-oriented process directed at creating something that has not existed before. Of course, design requires analysis in order to help us to understand where existing systems have gone wrong, and to evaluate design concepts, but the analysis needs to be relevant to the nature of the key activity - design. There would be little need to trace all the negative impacts in a complex natural system, if we could eliminate them altogether by design. We have created vested interests in environmental problems. This reflects the vestiges of 20th Century environmental management generally. For example, thousands of pages of analyses were written of the risks, impacts and life cycle costs of organo-chlorines in paper manufacture - when non-toxic paper bleaching alternatives were available (O'Brien 2000). Tools that measure the predicted impacts of a design proposal - rather than assist innovations that prevent or reverse impacts - are not really future-oriented. By default, such tools are often called 'design tools' although they are retrospective and encourage incremental improvements over the norm.

2. Impact reduction v impact reversal oriented

How do current building assessment tools actually work against impact reversal?

These assessment tools do not necessarily prevent eco-innovations that reverse impacts, but they are not designed to stimulate them. The time and energy they require to be devoted to studying the damage takes human resources away from finding alternatives that avoid them. The implicit assumption that net negative impacts are inevitable goes a long way toward explaining why we do not even try to design buildings that improve ecological conditions. We seem to regard developers a bit like criminals; that is, we make them listen to victim impact statements and take into account mitigating circumstances (like disadvantaged backgrounds and poverty), but we do little to re-educate them. Incentives are generally limited to reduced penalties and expedited approval processes. While we have schemes like sulphur or carbon trading schemes and transferable development rights. There is little credit for eliminating the externalities of buildings.

How can assessment tools facilitate design that has net positive impacts?

Assessment tools reinforce the type of buildings that the tools were based on in the first place, and thus favour engineering technologies over design solutions. However, as argued elsewhere, development can only be said to be sustainable if it improves human and environmental health, by supporting basic ecological (life support) systems. Common sense (and perhaps even laws of thermodynamics) suggest that we cannot replace 'free' natural systems with costly, resource-intensive engineered systems - let alone repair them after they are degraded. Put differently, whole systems efficiency requires that we enable nature to sustain itself and support human needs. This requires an entirely different kind of urban form. Hence we need to develop tools and processes that encourage us to modify the basic form and design templates of cities, buildings and landscapes, so that they create (and assess) the conditions for ecosystem services. For example, we need to develop criteria and indicators of (urban) biodiversity.

3. Building on templates v changing underlying systems

How do existing tools perpetuate basic design templates?

The extensive measurements required by 'green' assessment tools are much easier to input information into if one uses available data and makes marginal changes to the traditional (unsustainable) building template. But given the fact that buildings today shape our development options tomorrow, solutions that reinforce unsustainable development patterns could be seen as counter-productive, even if more eco-efficient than the norm. Currently, as long as impacts do not exceed that of 'best practice' buildings, there is no incentive to experiment, innovate, or re-examine basic design concepts: a building is seen as a winner if it is the 'biggest loser'. The investment of time and energy in design is seen as a luxury by some developers, but front-loading design could have a much better rate of return than hiring bean counters. To encourage eco-innovations, 'green' design methods and assessment tools need to be devised to look at whole systems efficiencies. The whole system is not just the building, but the bioregion (and the planet) as climatic and water cycles are global).

How could assessment tools encourage whole systems redesign?

The 'reference point' or benchmark for our existing tools are conventional building forms, spaces and materials. We are only measuring how far we are from home, not whether we are headed the right way. While awareness is growing that we cannot continue to destroy the natural life support systems, it is less well understood that we need to increase natural capital to support our population now, as well as into the long term future. Further, they are aimed at measuring the inputs and outputs of the parts, not understanding their internal transformations and contextual relationships. By developing design methods and assessment tools that map resource flows through the building site and city, we can work out ways to increase natural capital. Genuine progress indicators can suggest new ways to increase social capital in built environment design. Mapping the biodiversity of the pre-existing site and region, for example, can assist in finding ways to increase habitat in the urban environment. This is in contrast to the traditional engineering approach that seeks universal templates (partly just to facilitate measurement).

4. Universal engineering v natural systems solutions

Haven't good results been delivered through universal engineering solutions?

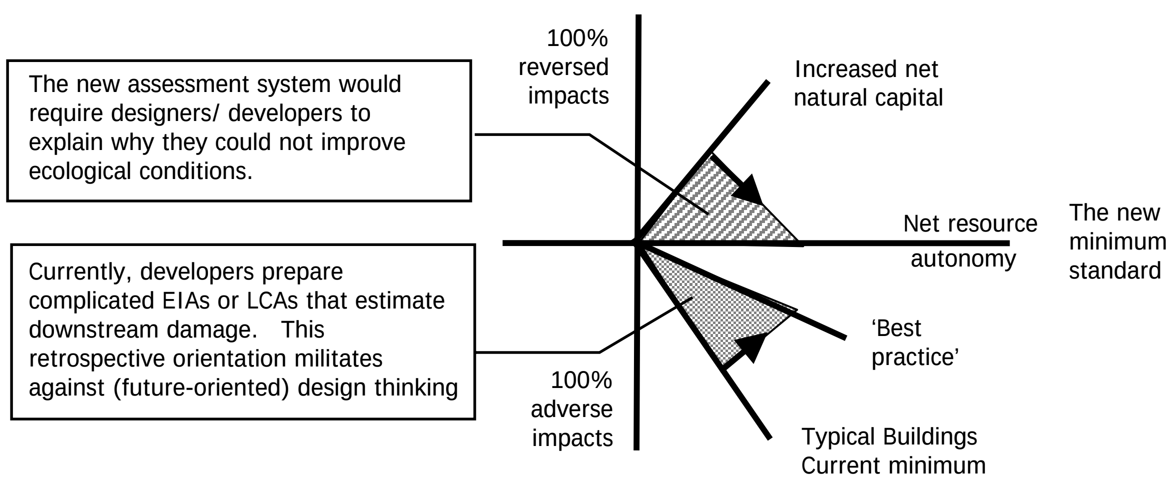
The perceived need to reduce everything to numbers for engineering and accounting purposes leads to biases towards mechanistic (measurable) approaches to design. Assessment tools do things like rank incommensurate variables (eg impacts on biodiversity and global warming), rely on expert opinion to determine the relative weightings of impacts (ie conventional wisdom), and use one number to compare different buildings on different sites with different functions.

Instead, we need assessment concepts and criteria that foster innovative design for specific sites and unique functions and avoid eco-efficient boxes that exclude nature. Whereas rating systems tend to prioritise technical fixes that improve the box, a Sustainability Standard would encourage stepping outside the box to focus on fundamental systems health and environmental flows (see Figure 1).

Do quantitative approaches actually militate against natural systems?

Analyses that aggregate the impacts of each step in the supply chain tend to divert attention from the stocks, flows and transformations of materials and energy in human systems. This can lead to sub-optimal solutions at the expense of whole systems rationality. Complicated processes for comparing components of buildings and then aggregating them can obscure opportunities for the creation of desirable feedback loops. Further, this division into sub-components in turn leads to trade-offs between the various parts. To find whole systems efficiencies, we need to map the design of the supply chain from resource extraction to product delivery, and to identify alternative means of satisfying the same needs. These can be anywhere on a spectrum from simple maps to facilitate brainstorming sessions to complex material flows analyses [see Design Methods].

Figure 1: Conceptual diagram of proposed assessment system



5. Aggregating impacts v whole system mapping

How does aggregation of impacts detract from whole systems mapping?

Because of prioritising number crunching over generating alternative design concepts, rating tools can create biases against the use of natural systems – if only because natural systems are hard to measure. Reliance upon an approach that appears objective because it is numerical can obscure creative new design solutions that are difficult to put into standard equations or frameworks. For example, air conditioning systems account for a substantial portion of electricity use, CO2 emissions and poor indoor air quality, but engineers prefer fixed windows to facilitate calculations of system or greenhouse gas performance (Roaf 2003). Natural ventilation can reduce indoor air pollution, but air quality is often not even in the equation. In other words, these tools squeeze investigators through a sequential, reductionist accounting meat grinder, but do not require them to consider whole systems. By comparing progress toward sustainability, a Sustainability Standard would encourage design and innovation.

How would a Sustainability Standard assist in finding systems design solutions?

Design is about synthesis and synergy, but because reductionist scientific processes have more prestige, design theorists have often tried to borrow from 'hard' science methods instead.

Reductionism tends to separate analysis and design, and to separate factors that are inseparable, such as human and environmental health. Isolated problems lead to narrow solutions (ie compact urban form could reduce car travel but impede other sustainability goals). Rather than focusing on the impact or efficiency of each variable, then, we would seek means by which the development can capture and enhance the free services of nature. A Sustainability Standard would be innovation-forcing, because it demands tools that assist in determining and improving whole systems health by, for example, mapping the relationships between and within systems helps to find win-win-win solutions.

6. Sequential and segmented v integrated processes

Isn't breaking down the inputs and outputs of each step a useful process?

Many assessment tools are based on life cycle analysis (LCA). LCA helps us to see the impacts over the life of the project, but they take a segmented and sequential - not integrated - approach. LCA is rapidly expanding its databases, but when you use an accounting tool, there is pressure to tick all the boxes, regardless of our limited understanding. For example, the view has frequently been heard in LCA circles that if the impacts are not known, they should not be added in, as that would create inaccuracies. Thus, remarkably, some LCAs have even left out a figure for a suspected toxin whose impacts biotoxic effects are as yet unknown (and about a thousand new chemicals are introduced each year without testing). This exclusion can have multiplier effects or lead to the selection of a material with unknown risks, so one such major omission can nullify the validity of the whole process. It would be better to avoid the use of any products with questionable chemicals altogether (ie apply the 'precautionary principle').

Does this imply that life cycle analysis tools can limit integrated design?

Although assessment tools may measure the whole life cycle costs of a development proposal, they do so by calculating the costs and externalities of the inputs and outputs of separate components and activities at each stage of construction. Instead of reducing 'waste' in each box, however, we want to find alternative designs that prevent waste in the first place (McDonough and Braungart 2002). Further, there may be means of rationalising the supply chain by looking at the construction system as a whole. For example, a consortium of private foresters, millers, designers and suppliers, brought together by one of our Sustainability Science Team eco-innovation workshops, joined forces to create efficiencies and ensure that all timber in the supply chain is sustainably managed and certified. This process was stimulated by systems mapping, not by increasing the efficiency of separate businesses, processes or components [See *Design Method*].

7. Data-driven indicators v mapping processes

In what way are current methods data instead of design driven?

In order to measure something, you need to have a solution in mind first. Before using the tools, developers/designers already have an investment of time, labour and ego in a proposal. Therefore, while they may be happy to modify and fine-tune it, they don't want to start over on the design (which is often inspired by the latest style). As assessment systems require a lot of data, proponents are better off using existing design patterns and materials around which data is easily obtained, and for which building approval processes were designed. Designers may also overvalue factors for which they have data, which is one of the reasons that people tend to use more energy efficient equipment instead of passive solar design which avoids fossil fuel systems in the first place. An illustration of data-induced myopia is the comparison of paper and Styrofoam cups. Few stop to realise that the coffee has more impacts than either cup, or what implications this has for environmental policy and systems design.

How can data-driven processes actually work against ecological design?

Data-intensive processes can work against design to the extent that they are not *subsidiary* to design. Most data are not really ecologically grounded, partly because the statistical sources were developed for other purposes. In other words, the data can be deficient with respect to some aspects of the design problem at hand, or used for problems outside the systems context in which the design was being developed. For example, there can be a bias against organic materials due to the lack of standardised data, whereas there is extensive data on recyclable steel, so it facilitates the assessment. Thus it is easier to specify and justify the use of steel than explore the potential of a recycled cellulous-based structures which can span as large distances as steel, and have lower life cycle impacts (such as the work of Japanese architect Shigeru Ban). However, compostable materials may be better in terms of whole systems health. This would be partly addressed if we mapped potential systems of production that are compatible and complementary to the bioregion (Birkeland and Schooneveldt 2002b)

8. Reductionist accounting v design reporting

How would a design approach differ from reductionist accounting approaches?

All kinds of analyses involve some reduction - almost by definition. However, if we just look at problems through an accounting framework (an intellectual microscope) we can miss other options and alternatives. That is, we can miss the forest for the trees. If developers/designers had to report on what they did to achieve sustainability against such sustainability criteria as in Box 1, it would help to refocus proponents on creative solutions. Specifically, it would require them to at least research existing sustainable solutions. That is, the proponents would be required to describe the efforts made to find sustainable design solutions. If the design did not achieve net positive impacts in key areas (eg water, soil, biota, air), then the Design Report would need to demonstrate that this was not yet feasible in the given context. An analysis of leading solutions would be less demanding and not require outsourcing to specialist consultants. More importantly, through the investigation of relevant eco-solutions, learning would be integrated with the design process.

How could Design Reporting encourage whole systems improvements?

Currently, we starve the design process while creating more bureaucracy: design improvements to human and ecosystem health mean expedited approvals. Developers of large-scale projects would have greatly reduced impact assessment costs to get development approval - if it can be shown to avoid or reverse impacts. The Sustainability Standard requires a more proactive design approach that is needed if we are to make quantum leaps over 'best practice'. This requires a method for visualising total environmental flows, not just the inputs and outputs of each component. Systems Mapping could be used in reporting as it is compatible with the nature of design thinking and the generation of innovative alternatives. The amount of data and measurement that is appropriate in design reporting would depend on the scale and complexity of the project (as in impact assessment). The degree of scientific analysis required for the Design Report would be a matter for the community and government.

9. Individual project v contextual perspective

Why is the wider regional and ecological context important?

The focus on an individual building and its components constrains the rethinking of building form and function in relation to their ecological and regional context. Sustainability logically demands that development be in resource balance with the bioregion. So if we want buildings and cities that are net positive, we need a design method and approval process that helps designers see the relationship between the structure and the wider bioregion. Mapping of resource flows can help to identify leverage points that can generate constructive ripple effects throughout the region. For example, a building can work to restore environmental health beyond the confines of the site by utilising wastes near their sources in the production of food, heat or soil. Thus the use of (sustainably-farmed) bio-based materials can contribute to rural revitalization as well as healthier indoor environments (as advocated by the Institute for Local Self-reliance in the US).

How can systems mapping assist whole systems efficiencies?

Mapping the development in the wider systems context can identify flaws in systems, not just components. For example, consider the enormous wastes from the wood-chipping of forests.

Industry might decide to use woodchips (or milling waste) as an alternative to fossil fuels in electricity generation or as biomass for methane production. However, while burning woodchips might arguably be an improvement over burning fossil fuels, it generates greenhouse gases and waste valuable organic material (ie involves negative trade-offs). Thinking in somewhat wider circles, we may wish to add value by composting the chips with appropriate additives to create soil conditioners, and thus remediate agricultural areas near the forestry operations. But from a whole systems view, these remediation uses for woodchips might delay the transformation from mining native forests to practicing eco-forestry. That is, tools should be restorative, not reactive.

10. Fossil fuel reduction v shift to solar resources

How can tools favour either fossil fuels or solar resources?

As said earlier, tools have focused on what is easily measured (eg reduction energy), rather than alternative systems using healthier energy sources (eg wind, passive solar design). A good example of measurement obscuring common sense design solutions is the emphasis on 'operating' energy. Because it can be metered, operating energy is relatively easy to measure compared to 'embodied' energy. At present, operating energy is about four times greater than embodied energy over the life of a typical building, so some have argued that we can ignore the embodied energy. However, most buildings are not passive solar (only about 3% of Australian homes use passive solar design). If buildings all took advantage of passive/active solar technology, embodied energy would become a significant factor because operating costs would become relatively negligible.

How could increases in solar resources be encouraged by Design Reporting?

The priority in reporting would be on the *source* of energy (ie whether from fossil or solar resources) as there is no shortage of solar energy. The requirement that 'green' alternatives be explored would make the designer think about finding better energy sources, rather than just specifying fossil fuel efficient equipment. Thus, instead of measuring the potential reductions in energy consumption of a proposed design over that of a typical building, any use of fossil fuels would have to be justified. For example, if the proponents argued that the payback period of solar resources is too high, they would have to show the payback period of conventional resources is lower from a whole systems perspective. If they were able to avoid fossil fuels through the use of passive solar heating, cooling and ventilating, however, their analysis and reporting costs would be lower. In part, rewards would flow from a new, less burdensome reporting system and post occupancy evaluation. But awards should be based on post occupancy evaluation (not predictions, based on computer models laden with hidden assumptions). We give Oscars to actors who give convincing performances, and we give ratings for designs with the most convincing assurances of predicted building performances, but little acknowledgment of post occupancy performance. Developments should get a payback from savings in externalities costs.

11. Reducing space v value adding space

How do we encourage more solar resources when we have less space?

Because most tools use energy to represent complex social and environmental systems, other fundamental design factors and resources are overlooked, such as space. Part of the growing demand upon urban and rural land and resources is due to converting land to a non-renewable resource through irreversible land uses. In contrast, the reversible and multiple use of space in buildings and cities is essential if we are to meet the criteria set out in Box 1. However, the conventional approach has been to zone buildings and cities spatially - to isolate built and natural environments - and allocate less space to each. Instead of giving each function less space, we should optimise spatial resources by designing interior and exterior spaces to perform multiple, integrated, ecological and social functions simultaneously. Sustainable (net positive) development would entail the integration of landscape and built environment functions and reversible land use (such as compostable building materials where appropriate) [See *Design Paradigm*].

How would increases in spatial resources be measured?

Our conventional measures of space are not very useful in design. Space is generally measured in reductionist, non-qualitative terms (eg dwellings/hectare). For example, people cannot seem to agree on whether more space/person or less space/person is a good sustainability indicator. Green open space (both internal and external to buildings) has been largely overlooked as a means of accommodating the ecological, social and economic needs of urban residents. While solariums or living machines can provide ecosystem services and 'free' heating, cooling and ventilating, they can also create more interesting and healthier working environments. Therefore, the aim of spatial design should not be to reduce space per person (or dwellings/hectare, etc) but to reduce resource consumption per person while increasing accessible social space, amenity and ecosystem services. By maximising the 'environmental space per person' - we can simultaneously enhance adaptability, increase both social and natural capital and reduce consumption. An essential element in the multi-functional use of space is design that supports ecosystem services. We cannot protect, preserve or enhance ecosystems services by trying to isolate and protect them in regional areas. If we are to use the term ecologically sustainable development, cities and buildings must become far more self-sufficient ecologically than present assessment and rating tools contemplate.

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