

Qualitative Spatial Reasoning and LCA in Green Building Design

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Life cycle assessment (LCA), and life cycle thinking in general, has greatly enriched the tools available for green building design. Nonetheless, it remains just part of the comprehensive decision-making process required for sustainability, where project design teams are challenged by the complexity of considering multiple factors simultaneously. To make the process more manageable one can either ignore complicating relationships or develop a better way to manage these complexities. This presentation explores the latter possibility by proposing a novel method to support the application of informed common sense to building design while incorporating many considerations currently absent from the process. As life cycle costing (LCC) methods evolved to include the related environmental impacts through life cycle impact assessment (LCIA), so can we now begin to incorporate another missing dimension—the human impacts of certain materials, products and strategies.

To be successful however, we must embrace an approach suited to the simultaneous consideration of the economic, environmental and human impacts equally without reducing all three to a linear scale of mere financial costs. What is necessary is a shift in our way of thinking as revolutionary as the concept of sustainability itself. By using ‘qualitative spatial reasoning’ we can easily add the human dimension, reduce the abstractions from source data, and make the process understandable to all project stakeholders.

By expanding the standard two-dimensional grid, representing the economic factors on one axis and the ecologic factors on the other, to include a third axis addressing human factors we build a three-dimensional framework where qualitative spatial reasoning can occur. While the economic scale tracks the relative efficiencies or costs for each functional unit (material, product or strategy), the ecologic scale traces the relative impacts to the natural environment, and the human scale records the benefits or burdens to human participants of the built environment related to health, comfort and psychological well-being.

Most innovative is that within this model the environmental and human factors are no longer collapsed into economic quantities, abstracted numbers, or convenient LEED* credits but are addressed *directly* as prioritized values related to their context through a group weighting exercise. By doing so, the apparent conflict between costs on the one hand and either the environment or humans on the other is resolved into a way that ranks each quality independently along its particular axis *and* relates them collectively within the framework. Therefore, the methodology encourages a form of ethical, value-based decision-making particular to the project stakeholders, project location and its region that resists *de*-valuation into monetary terms. It is also consistent with the long-term demands of sustainability, with its holistic focus on the complex interrelationships within the greater environment.

An ideal combination, qualitative spatial reasoning can harness the wealth of life cycle inventory (LCI) data through dynamic, continuously updated links filtered by region, climate (biome), and typology. Likewise, LCA can take advantage of a more balanced analysis method that considers the goals of each perspective (economic, ecologic and human) and acknowledges the expert judgments, ad-hoc assumptions and subjective interpretations inherent to the process. After all, qualitative reasoning is just common sense used in absence of precise quantitative information. As we recognize the computational limits to our knowledge and consider aspects poorly translated into economic terms (like productivity or psychological health) we must embrace value-based reasoning.

Traditionally the weighting of factors is the least developed stage in LCA, the most difficult for users, and the most suspect contributor to the final appraisal. Using this methodology however, the value assessment process is easy to understand and employ. In green building design for example, an essential step is a group exercise where all stakeholders meet first to establish the project’s economic, ecologic and human goals and parameters and then, to consider design alternatives to achieve those goals. This weighting exercise shares the decision-making process, builds teamwork and consensus. When combined with qualitative spatial reasoning it should produce a better building design—one that is more respectful of the integration of economic, ecologic and human needs. If the success of sustainability relies on doing what is right and not just what is within budget or only what can be quantified, why do we continue to use abstract numbers or costs as the denominator for our reasoning methods?

* The LEED™ Green Building Rating System is a national program to rate buildings by a prescriptive checklist of credits.