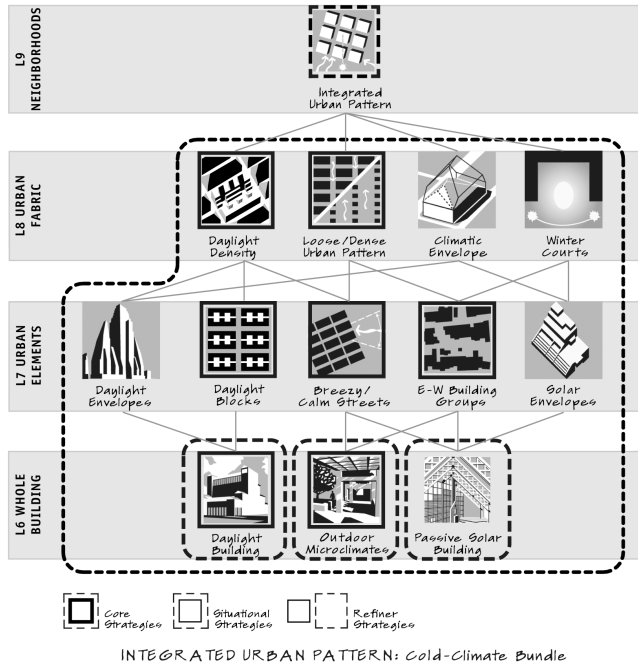


**A NEW KNOWLEDGE STRUCTURE
FOR DESIGNING NET-ZERO ENERGY BUILDINGS**
FINAL REPORT on the AIA UPJOHN INITIATIVE AWARD

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May 1, 2013



Example of a Design Strategy Bundle diagram

ABSTRACT

Architects are behind at achieving Architecture 2030 goals for all buildings. One barrier is a lack of sophisticated knowledge and tools. This project aspires to accelerate the profession's progress by removing that barrier. **The first problem** is that existing energy design guidance exists as disconnected and discreet ideas or techniques with little way to connect them or to decide which ideas to use for a particular building type, use pattern, and climate. **The second problem** is that the synergies and conflicts among different issues (e.g., heating, cooling, and lighting) are not revealed by current approaches.

Our hypothesis is that we can generate, test and publish an integrated knowledge structure for net zero energy design that will help designers choose families of design strategies and, thereby, broaden the number of designers and improve the sophistication of their designs.

This project organizes much of the knowledge of **net zero energy building preliminary design**. Key to identifying relationships among strategies are three methods we



Students at Tennessee playing Bundle-Up!

developed: 1) The **Design Strategy Map method**, which allows us to map over a hundred existing design strategies, **Strategy Bundles**, which reveals the 'horizontal interrelationships' among the issues. 3) A third approach, **Net-Zero Decision Charts**, uses a **design question-driven method** for selecting design strategies and linking them together into Strategy Bundles.

PRODUCT: STRATEGY BUNDLES

We define a **Strategy Bundle** as a set of related strategies that work together to resolve commonly occurring design problems. Nine "fundamental bundles" have been outlined in concise multi-page spreads with example and design decision tools for each.

See the file: Strategy_Bundles.pdf

PRODUCT: BUNDLE-UP! GAME

The game is a teaching and learning aid for classes and a collaborative team design tool for design professionals. It was pilot tested with university teachers at the Society of Building Science Educators and subsequently with several classes at the University of Tennessee. Students testing the game were second year and fifth year undergraduates.

The Bundle-Up! game has received an additional funding from the University of Tennessee for development and testing.

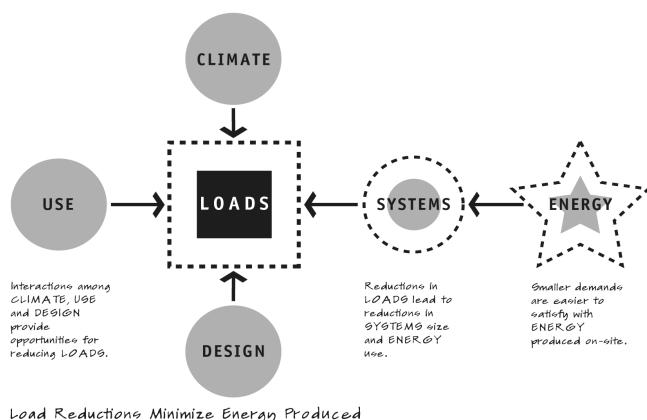


Example of collaboratively created strategy bundle

See the files:

- Bundle-Up_Game_Board.jpg (reduced from full size)
- Bundle-Up_Playing_Cards (sample of full set)
- Bundle-UP_Instructions.pdf

Full sets of the physical game are available from Mark DeKay.

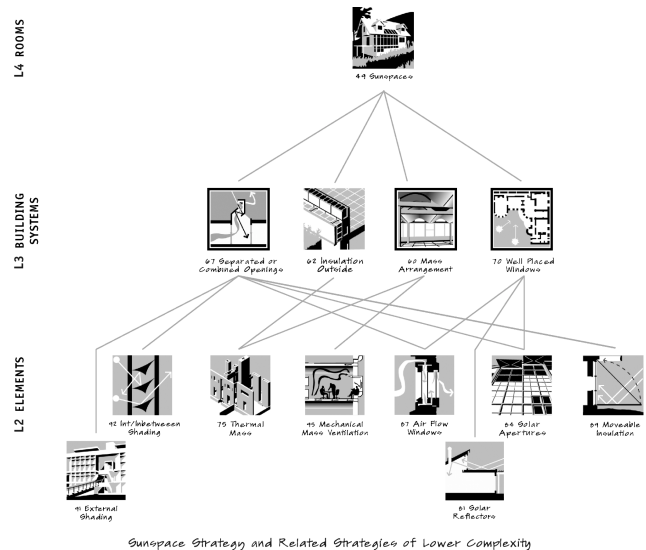


One of several illustrations for a net-zero energy design process using the new knowledge structure

PRODUCT: SEVEN SYNERGIES FOR ENERGY BALANCED BUILDINGS

The decision charts helps make critical decisions in the net-zero energy design process and directs users to a set of seven “synergies” and a larger set of related design strategies and design strategy bundles.

This tool has been tested with graduate and undergraduate students in their terminal studio (2 terms, 28 students); with design professionals (SRG Partnership, ~ a dozen designers); has been presented to educators (Society of Building Science Educators, 40 -50 attendees); and has been



An excerpt of the Design Strategy Maps showing strategies potentially associated with the Sunspace strategy

evaluated by the Northwest Energy Efficiency Alliance for its market transformation value.

See the file: *Synergies.pdf*

PRODUCT: DESIGN STRATEGY MAPS

These were originally called “Pattern Maps” in the proposal. They show the nested hierarchical spatial relationships between design strategies in a nested, lattice-like network. The Design strategy Maps are used for several purposes: mapping the extent of the energy design knowledge base, finding what strategies are known and unknown; helping to build Strategy Bundles and as a reference in the Bundle-Up! game. They can also be used as a structured way to explore potentially related strategies in a design process.

See the file: *Strategy_Maps.pdf*

PRODUCT: PUBLISHED BOOK

The results of this research are being published in an entirely new printed edition of *Sun, Wind & Light: architectural design strategies*. The manuscript and all illustrations are complete and is at the publisher, John Wiley & Sons. The products from this project form the majority of the 400 pages of new work. The additional 450 pages of design strategies (including all of the content from the 2nd edition of *Sun, Wind & Light* is being published in the electronic component of the work. Publication is expected in late summer 2013.