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Extended Abstract

ENABLING ADAPTABLE BUILDINGS: STRATEGIES FOR DESIGNERS

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Abstract:

Obsolescence is one of the most common, yet least understood "hazards" affecting the built environment. Obsolete buildings are often demolished before the end of their usable life—a practice that can have significant social and environmental costs. This paper discusses the sustainability consequences of obsolete buildings and the potential of adaptability as a mitigation strategy. In particular, eleven different design-based enablers of building adaptability, as identified through a systematic literature review, are described. Current work and future plans for creating a design intervention based on enabling adaptability are also briefly discussed.

Introduction and Background:

The global society is confronting unprecedented and accelerating trends in urbanization, climate change, and technological transformation. In this dynamic environment, obsolescence is becoming one of the most significant "hazards" facing the built environment. A survey of 227 building demolitions in Minneapolis-Saint Paul, Minnesota between 2000 and 2003 revealed that obsolescence was a primary reason for demolition in 61% of the sample. Lemer (1996) defined obsolescence as "something that does not measure up to current needs or expectations." Lemer further observed that obsolescence is triggered by social, economic, technological and regulatory changes.

Whereas unforeseeable change is a primary cause of obsolescence, adaptability is a primary tool for maintaining relevance. In the context of buildings, adaptability is herein defined as the ease with which building structures and envelopes can be physically modified, deconstructed, refurbished, reconfigured, repurposed, and/or expanded. The link between unforeseeable change and adaptability was succinctly summarized in a paper by Jennifer O'Connor (2004): *"Rather than attempt to predict the future and design permanent [building] structures with infinite lifespan, we are probably better off in acknowledging our inability to make predictions and instead design for easy adaptation and material recovery."*

In keeping with O'Connor's admonition to "design for easy adaption," this paper makes two technical contributions. First, the existing literature regarding the strategies and practices for enabling adaptability is summarized. Particular attention is given to enablers that are within the control of building designers. Second, the results of a survey are presented in which design professional rated enablers according to their effect on adaptability. The results elucidate which strategies and practices are most effective at enabling adaptability.

Adaptability can have positive affect on sustainability (e.g. Bullen, 2007). Economic and social sustainability can be facilitated as buildings are reconfigured to satisfy changing market demands and social aims. Environmental sustainability is realized as adaptable buildings are repurposed and/or deconstructed rather than demolished.

Design-Based Enablers:

The enablers of adaptability have been widely reported in the technical literature, and can be characterized as being design-based or process-based (Gosling et al., 2013). Design-based enablers are manipulations to the design that increase the potential for adaptability; process-based enablers are characteristics of supply, construction, and operational systems that increase the system's ability to adapt and accommodate change.

Eleven design-based enablers of building adaptability, identified through an extensive literature review, are briefly discussed below. One reference is provided for each enabler; a more comprehensive list of references will be available in a forthcoming paper being prepared by the authors. Words in *underlined italics* in the list below are shorthand labels used for the enablers.

- *Layer*ing of building components according to varying life-cycles and functionality allows systems to be replaced when necessary with minimal consequence to the remaining components. (Brand, 1995)
- *Reserve* capacity is an excess of strength designed into a building from the start so that any change in future demand, through either code or functional changes, can be absorbed by existing components. (Slaughter, 2001)
- *Open* floor plans have interior spaces free of columns, bearing walls, mechanical equipment, plumbing, etc. Partitions in such spaces can be readily changed to suit different functional requirements. (Arge, 2005)
- *Simple* building and component layouts reduce the number of unique conditions and organize buildings in a repetitive manner. This streamlines the design process for future modifications. (EPA, 2010)
- *Modular* and interchangeable components produce a set of standard sizes and interfaces for components to be used in multiple locations in a building. (Webb et al., 1997)

- *Design for deconstruction* (DfD) is a strategy that plans for the reuse of building components at the end of the building's service life. DfD contributes to the reuse and recycle of building components, positively benefitting the environment. (Davidson et al., 2011)
- *Common* component sizes and details throughout an entire building help to facilitate adaptation schemes that can be reused throughout. (Webster et al., 2007)
- Components made of appropriate *materials* can outlive the functional life of a building, and can be reused in later projects. It is important that materials are both non-toxic and durable. (EPA, 2010)
- Mechanical *connections* allow components to be easily removed and replaced without causing damage to the component or any surrounding components. (Slaughter, 2001)
- Accurate *plans*, models, and condition records minimize risk and uncertainty and assist designers in making appropriate decisions for future renovations. (Brand, 1995)
- *Access* can be provided for inspection and/or maintenance of critical and often-replaced components. (Morgan et al., 2005)

Survey of Design Professionals:

A total of 15 design professionals, having an average of 19 years of work experience, were surveyed to evaluate the relative effectiveness of each design-based adaptability enabler. Participants for the survey were recruited through professional organizations and through the third author's professional network. In particular, professionals with experience in reuse and adaptation projects were recruited. Survey participants included individuals with background in architecture, structural engineering, mechanical (HVAC and plumbing) engineering, building envelope design, and construction management. Survey responses were averaged, and are presented in the figure below in terms of the percentage of adaptability attributed to each enabler. The values are relative, thus *plans* (13.8%) is roughly twice as effective as *modular* (6.5%).

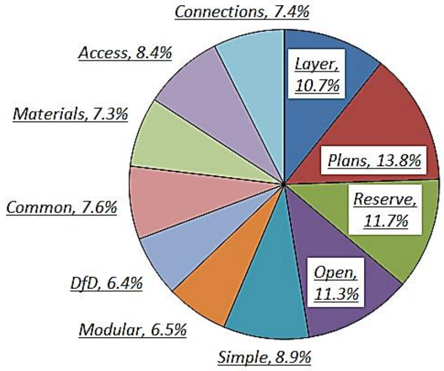

Figure: Relative effectiveness of design-based enablers

Summary, Conclusions, and Future Work:

A comprehensive literature review was conducted, resulting in identification of eleven different design-based enablers of building adaptability. Fifteen design professionals were then surveyed to determine which of the design-based enablers are most effective in promoting adaptability. The survey results suggest that the most effective enablers are accurate information (i.e. *plans*), *reserve* capacity in building components, *open* floor plans, and *layer*ing of building systems. The authors are currently working to expand the survey pool, identify interactions between enablers, and create a quantitative model for assessing adaptability. The intent of these efforts is to provide resources for designing an adaptable built environment that is inherently sustainable, resilient, and relevant.

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