Diversified longevity – an architecture of disengagement and localized production

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Abstract

The work presented here introduces and describes a new suite of concepts that regulate the designated longevity of contemporary buildings in ways that derive from the generation, metabolism and termination of life forms. The concepts of an architecture of disengagement and localized production are regulated by the Theory of Diversified Longevity for a fundamental reformulation of the designation of obsolescence for built form. Through this reconsideration of lifetimes, buildings may become more attune to, and therefore responsive of evolutionary forces that arise from user needs, economic flux, demographic changes and other contextual elements. The overall intent is to allow a greater flexibility in the accommodation of present needs while providing for anticipated and unanticipated future uses. The intent is achieved through a process that does not require the accurate prediction of any particular future scenario. The value of such a process resides in the fact that the building then possesses a range of lifetimes, and by consequence, a range of embedded attributes such as embodied energies, adaptive reuse possibilities, materials systems, rearrangement options, initial cost and durability. Each section of the building carries within itself a genome that specifies its longevity and determines its service life. The theory is applied to an ongoing design commission for which the research project team is involved.

1 Animated form

Animate forms may be distinguished from inanimate structures by examining the broadest range of characteristics of the lifetime of the organism. From initial generation through end-of-life termination, the ability of the organism to metabolize and sustain its own processes, to seek out energy sources, and
actively reproduce distinguishes a living being from a highly ordered molecular structure. While most living things may be characterized as achieving all of these qualities, there are exceptions to this classification. Viruses are the best example of a highly ordered mechanism that is difficult to classify as either living or not. Crystalline structures also exhibit all of the qualities listed, and yet are clearly not "living" things. Buildings are also not animate structures, at least not in an organic sense. However, the invocation of the formal attributes of living things has been a time-honored source for innovation in design. This particular dynamic has primarily focused on the links between the actual forms of living things and the configurations that designers have invented. From the use of the leaves of the acanthus plant for Corinthian column capitals to the structures of Pier Luigi Nervi and Felix Candela and, more recently, the bridges of Santiago Calatrava, nature has always been a fertile source of form and structure [1][2][3][4].

In recent years, the extended analogy of nature as a source of, not only extraordinary form, but also exceptional processes has been a productive avenue of investigation for design technologies. The processes, ecosystems and complex evolutionary relationships of living things have brought a rich and diverse set of examples to those interested in developing sophisticated process technologies. Several multi-national corporations have taken seriously the notion of developing sophisticated industrial ecologies that identify productive sources of raw material from waste streams. In addition, work in neural networks, robotics and genetic algorithms has also benefited from investigating the relationship between living organisms and the environment through flows - energy and material - in time. More than one author has used the natural world as a source of inspiration for innovative processes and speculated on various applications; industrial, economic, cultural and otherwise [5][6][7][8].

The work presented here uses the broad outline of animate lifetimes as a departure point in developing architectural strategies that promote adaptability through time.

1.1 Lifetimes

It is useful to begin by examining the process of life by distinguishing between the stages of generation, autonomy, metabolism and termination.
Figure 1 shows the animate cycle as a series of discrete steps. These steps have their corresponding objects and processes in architecture; 
A = construction, B = completed building, C = operation and occupation, D = decommissioning and demolition.
The three arrows that converge on A designate energy, material and an organizing protocol. The organizing protocol refers to the process of germination and gestation in organisms and construction in architecture. B represents the autonomous organism, that is, the completed building. C is the process of metabolizing, growth, change and aging and D encompasses the dispersal of material, energy and organized protocol that has been developed during C.

![Diagram](image)

**Figure 2: Analogous cycle in the construction process**

The arrows surrounding letters A and C, the construction and operation of the building respectively, denote processes that dominate these stages. It is during these processes that the designer is most influential in determining the level of flexibility and evolutionary possibilities embedded within the architecture.

### 2 Flexibility and evolutionary potential

Organisms are eminently adaptable within their ecosystems. Given an appropriate ecology in which to situate themselves, organisms are ideally suited to contend with a great range of changes. In addition, ecosystems themselves adapt to stresses through a wide variety of mechanisms only now being fully analyzed by scientists.

In contrast, the construction and use of buildings is accomplished through methods that discount the potential for adaptation and response to change. Most systems of procurement, construction, operation and termination of buildings is accomplished through the expenditure of a great deal of energy and materials that are subsequently segregated from any continued utility in mineral or
biological cycles. Much demolition waste produced is simply segregated from any continuing cycle of reuse either in construction or other sectors of the economy. Such unsustainable processes are receiving a great deal of attention from design professionals, engineers and policy makers interested in minimizing the use of nonrenewable materials and energy.

The approach taken here investigates the potential of developing adaptive architecture through a careful reconsideration of building lifetimes. This paper proposes that two lifetime strategies need to be developed to allow for appropriate flexibility and evolutionary potential. These two strategies are the following:

1. Disengagement architecture: strategies for the separation of building components, assemblies and entire systems from one another over the course of a building’s service life, and
2. Localized production: the ability to reconfigure spaces and assemblies, reprocess materials and reincorporate reclaimed elements through production processes located on-site.

These two ideas are summarized in Figure 3.

![Figure 3: Building-sized module disengagement and localized production](image)

First, it is necessary for the building to achieve a rational and reasonable level of disengagement at several levels; at the material, component, assembly and full building level. While the disengagement between materials and components is important for a sustainable and recyclable architecture, the work here treats the disengagement that occurs between large-scale assemblies and building sections. Figure 3 shows the material reclamation of module 1, at the end of its service life, for the construction of module 6. For a truly flexible architecture, the building itself may be able to cleave strategically to allow for the types of change that occur commonly, if not efficiently. That change can be characterized as change due to scenario-shift.

2.1 Scenario-buffered design

Scenario-shift is the type of fundamental change that renders entire buildings obsolete or without reasonable reuse. These shifts may be of the following type:

- Programmatic change
- Imposition of critical regulatory burden
Demographic and economic transformations

Brand has characterized a planning and design process that takes into account the likelihood of future shifts in scenario as scenario-buffered design [9]. He considers scenario-buffered design as a superior method for hedging the future and producing a more flexible, responsive and ultimately responsible building.

The great vice of programming is that it over-responds to the immediate needs of the immediate users, leaving future users out of the picture, making the building all too optimal to the present and maladaptive for the future. An old saw of biology decrees, “The more adaptive an organism to present conditions, the less adaptable it can be to unknown future conditions”...

The iron rule of planning is: whatever a client or an architect says will happen with a building, won’t. [9]

And, as opposed to the process of envisioning the correct future, scenario-buffered design attempts to develop strategies by which the building may “attend to the future”. In addition, Brand also refers to the notion of future preservation advocated by Kevin Lynch [10]. Future preservation advocates treating the design of buildings as a service in time. Design is focused on achieving an appropriate durability as well as engineering into the building itself the ability to adapt for any number of future scenarios.

Scenario buffered design also places value on construction modes that allow for an inconclusive finish to the building. In some instances the best strategy may be a range of conclusions at the completion of the building. In other words, as opposed to completing the building all to the same level of finish, the designers may purposefully leave certain areas “unfinished”, or simply finished to a significantly lesser degree. This would allow the users to determine the appropriate materials to be used, as well as allowing the organization to monitor the evolution of use of the space and then plan accordingly.

Second, the process of reclamation of materials and reuse occurs almost entirely on site. For the purpose of significantly reducing the energy costs in transportation, the building has the facilities and capacity to reprocess all materials made available from the decommissioning of specific sections. This localized production leads to a continual process of renewal and reconfiguration that maximizes the efficiency with which materials are used and reused. It also offers a great deal of flexibility to the users to periodically redefine the space that serves them.

2.2 Efficient engagement and ease of disengagement

In order to serve the intelligent segregation of materials towards productive reuse cycles, the construction and decommissioning stages must develop details for the engagement and disengagement of materials during construction and deconstruction, respectively. In addition, for maximum ability to evolve with lifetime use, the building should develop methods for producing and reusing materials and assemblies that are localized and sustainable.
3 Diversified lifetimes and localized production

Various theories have been promoted for the production of a flexible architecture. Strategies for making flexible architecture remain rather vague due in part to the enormous complexity inherent in regulating the relationship between hundreds of distinct components serving various independent and semi-independent building systems. The most specific guides have been lists of rules that organize the kinds of design strategies to determine the making of a flexible architecture through component design [11].

The Theory of Diversified Longevity offers an alternative. Rather than depend on the design of flexible components as the only strategy for a flexible architecture, a consideration of the embedded longevity of large-scale building sections could yield a more flexible architecture simply by varying the lifetimes of the sections themselves. That is, the longevity of a building—the predetermined obsolescence—usually considered to be one length of time (Figure 4), such as 50, 65, or 75 years, can be composed of several separate service lives, assigned distinct durations and distributed throughout different sections of a large building (Figure 5). Large-scale buildings may be best considered in terms of a range of lifetimes that easily allow for a variety of futures. The needs of the original occupants and the range of future occupation possibilities should determine this longevity distribution and the range of lifetimes for the future. The overall intent is to allow a greater flexibility of present use and accommodation of anticipated and unanticipated future uses.

Therefore, while there is ongoing work to determine the single service life of a facility, the problem of accurately predicting future use remains [12][13]. However, by diversifying lifetimes, an accurate divination of the future is not necessary. The value of such a process—the planned diversity of decrepitude—resides in the fact that the building then possesses a range of lifetimes, and by consequence, a range of embedded attributes such as embodied energies, adaptive reuse possibilities, materials systems, rearrangement options, initial cost, and durability. The building therefore, in its production, has been imbued with a diversified range of obsolescence codes. Each section of the building carries within itself a genome that specifies its longevity.

This alternative method allows for a redefinition of the necessary initial investment and the resultant real estate value of large-scale facilities. A simple
example can be rendered as follows: a building may be designed, specified, and built with the typical 50-year life, as defined by contemporary practice. Alternatively, that same building may be designed with a range of lifetimes distributed over the built area in a mix, for example, of 5% at 3 years, 10% at 10 years, 20% at 25 years, 50% at 50 years, and 15% at 100 years and beyond.

Clearly, the 15% of the building built beyond the typical 50-year limit will be more expensive to build. More durable materials and greater care in construction will normally place a premium on this portion of the building. That added expense may be offset by the 35% built at a shorter duration than the 50-year mark. The precise calculation of an optimal mix would depend on the correlation between needs and the specific material systems and construction techniques employed. However, the ramifications of such a strategy would yield interesting results.

Figure 5: Heterogeneous lifetime model

Figure 4 shows a simple 50-year life design. Figure 5 shows the diversified lifetime model with each section charted in terms of its area contribution and service life.

First, the tenant would be obliged to reconsider their space demands at the end of 3, 10, and 25 years before the building reached the commonly accepted lifetime limit of 50 years. While this is an added responsibility in the use of the building, it would also allow an incremental reconsideration of the facility’s needs, and provide a method for acting on that reassessment. At any of these three points during the use of the building, the owner could decide to remove those sections of the building permanently. Figure 6 shows the progression over time of the various portions of the building as they reach their respective obsolescence dates. The arrows above the lifetime sequence represent the material that is circulated back into the facility. This material is reclaimed and recycled, serving as both a source of raw materials for additional construction as well as a method by which the facility minimizes its overall embodied energy.

Furthermore, diversified lifetimes allow the user to reconsider each section and its contribution to productivity and its drain on resources. For example, any underutilized section could be decommissioned and would not then incur further running costs, such as energy, lighting, maintenance etc., and the removal of the piece would allow for a net savings to the owner. On the other hand, if the piece is essential to the owner, it could be rebuilt, now with the
option of a service life longer or even shorter than the original. Thus, the owner would have options for the manipulation of the physical facility that are not available otherwise.

Second, the overall building could be built with a lower total embodied energy. A building of diverse lifetimes could orchestrate a more precise delineation between user needs and the embodied energy costs incurred.

Third, a building of diverse lifetimes may evolve to suit an evolving business or process more readily than monolithic single-life construction. Production factories would be able to reassess the performance needs placed on their facilities at discrete increments and act to more easily remove or modify those portions.

Fourth, the exit strategy for each section would be a liberated store of potentially useful material. These components could be an ongoing material transfer back to the building or to the community. The incremental exit strategy of the facility – obsolescence in pieces – would also avoid the problem of the entire facility reaching its termination date at one time.

Fifth, the building would have the ability to enter into a lifetime of use in the next generation for the portion designated to last far into the future—100-300+ years. However, the next use would most likely not be in the service of the original owner) and therefore the embedded value of the long-lived section would transfer to the community or another owner entity.

And finally, a diversified lifetimes approach would acknowledge the uncertainty of the future intensity of use by providing a range of evolutionary patterns. As a result the under- or over-utilization of the building and the site would be reduced, and possibly eliminated altogether.

Using the same graphic introduced above, with time charted horizontally from left to right and occupied space on the vertical axis, the profile of the building’s evolution over time could resemble any one of the diagrams shown in Figure 7. Each diagram shows the profile of the occupied space over
time. In A, the building decommissions each separate section as it reaches ultimate age; B shows the building's expansion over 50 years; in C, the building contracts dramatically and ceases to provide for any occupied space; and in D, the building's occupation extends beyond 50 years. Each of these scenarios can be accommodated by reassessing user needs during the building's occupation and accessing the diversified lives embodied within the distinct building sections.

![Figure 7: Evolutionary modes for a building of diversified longevity](image)

The ability to accommodate the scenarios above, individually or in any combination, also results in a lowering of the overall risk to the owner. A building that may accommodate change during various scales of time will reduce the risk that the facility will become underutilized or overstressed. Each terminal date also provides a period of renewal in which the facility lifetime may be reassessed and the design and construction of any additional pieces may respond better to a more accurate picture of the users' needs.

4 Conclusion

The strategies of diversified lifetimes and localized production are important for the simple reason that they provide many more options for a building to creatively respond to the environment, including the users' interests. And as users interests change, the building may respond accordingly. In addition, the building may also be able to evolve into an agile material resource.

It is also interesting to note that the diversified lifetimes approach to the design of buildings has great potential for more efficiently managing the real estate assets of large building owners by spreading the risk of meeting the facilities demands on the business.

Notes

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