Giving Our Ideas a Playground, not a Contained Shoebox

numerous thoughts on the digital design process and the reasons why it is a creative step forward

by Andrzej Zarzycki

The term “design process” might be seen as an oxymoron, however it is an interesting combination of contrasting words. The word “design” suggests a creative endeavor with unlimited possibilities, not tempered by predictable or predetermined patterns. It also suggests something new and out of the ordinary. From a different perspective, the word “process” implies a systematic course of action that brings about a result. It implies a course of action that is both deterministic and goal oriented.

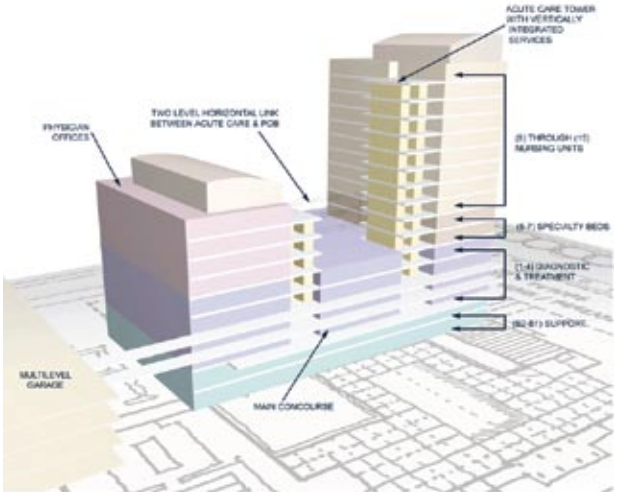
Indeed, the phrase “design process” captures effectively the dialectic tension and meaning of a creative struggle. This apparent contradiction underlines two formative components of a successful design process: generative and implementive. The first component ‘wants’ to be creative, unrestrained by the current state of knowledge and is occasionally provocative. The other component is systematic and hierarchical with reasoning based on critical thinking. However, these two distinct and polarized ways of thinking: hierarchical or generative, didactic or inductive, have to occur together since neither one alone is sufficient in facilitating the creative process. Thus, the “design process” is a fused dichotomy of design generation and the process of its implementation.

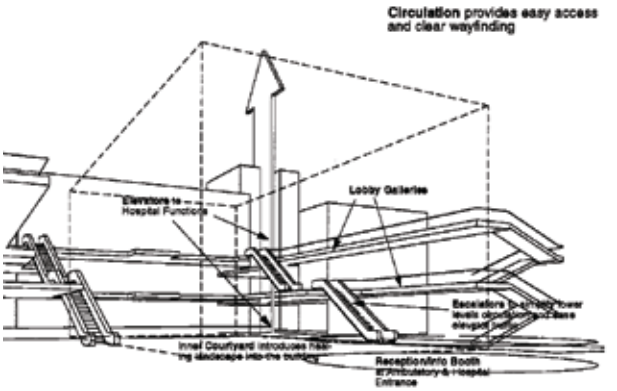
The distinction I made earlier between generative and implementive (design and process) is critical. The concern with design process based architecture is that it often has too much process and not enough design. By process in this particular context, I mean a highly didactic form of reasoning, while self-consistent and self-integrated, relies heavily on arbitrary propositions. This reliance is not in question, but rather its unapologetic confidence and presumed righteousness. This methodology often confuses intellectual beauty for visual beauty; intellectual construct for visual and emotional experience. There seems to be a conviction in the architectural profession that good process can justify the final design on the merit of its process alone. While this is often an effective way to convince a client or justify our actions to colleagues, it does not guarantee design or creative excellence. Not choosing one way of thinking—simply hierarchical alone, but benefiting from both—hierarchical and generative—is necessary for a successful creative thinking/process resulting in a creative end-design.

While touching on several aspects of the design process, this article focuses primarily on the generative aspects of design with an emphasis on the new and renewed role of digital tools within its spectrum. Specifically, it discusses how digital tools continue and reuse traditional (analog) modes of creative thinking, as well as emerging possibilities specifically connected to the digital interface.

This article’s argument points to specific modes of creativity that facilitate in breaking established mental patterns within creative thinking. The design goal should be to increase flexibility so that the design can evolve with project constraints and sensitivities, not just according to our own internal reality, or as controlled by our initial propositions. Rather than to force the design to become a simple consequence of our initial assumption, it is important to set up a framework that allows the design to flourish and in turn optimize our initial assumptions.

The question about how one goes about reframing her own frame of reference or restructuring his thinking patterns, is central to any creative endeavors. How do we develop innovative ideas based on past experience? How do we learn from the past, without becoming predestined to replay it? This article does not aspire to answer all these questions, but rather attempts to position various current creative developments within the digital design scene; which in effect connects emerging design strategies. The examples discussed in this paper are narrowed to tectonic expressions—otherwise known as model based modes of





Figures 1-3: Commonly, the design process is associated with hierarchical and sequential refinements as shown above. A linear design process is concerned with idea development and delivery. A process with a predetermined direction and a predictable class of solutions.

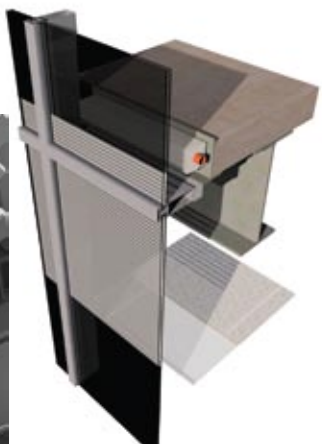
creativity. However, the discussed ideas and posed questions are relevant to broader aspects of creativity.

Limitations of Purely Hierarchical Thinking

The design process involves the progression and successive resolution of an idea through a series of phases--from general to specific. Architecturally, these would be schematic design, design development, and construction documentation (Figures 1-5). Design starts with a set of assumptions and progresses through a series of deducible events or propositions preserving the underlying initial logic. At each stage, the initial idea does not change, but is further refined to address the evolving constraints and sensitivities relevant to this particular phase. The design methodology, in the traditional (deductive) approach is highly scripted resulting in more refined ideas, but at the expense of the reduced flexibility. While this is acceptable for the final design product, it is not desired for the intermediate design stages, because this obscures alternatives that may be more suitable for the final resolution.

The didactic process can be scripted into discreet steps, each step testing or resolving a particular design aspect. This hierarchical and linear methodology narrows a number of paths the design can follow. Additionally, the sequential logic associated with the didactic process obscures the solutions (events) that lay outside the immediate logical horizon, making it difficult to move laterally and develop alternatives. Furthermore, the traditional step-by-step thinking builds an inertia of predictable conjectures leading to deterministic outcomes, or in order to move beyond it requires an imaginative leap of causal thinking that would not be consistent with a purely didactic methodology. Some might argue that struggle is necessary in order to find greatness or success in the end-result. In pop culture, people refer to this as the all-important “ah-hah” moment.

Figures 4-5: Digital models of construction details.



Points for Generative Thinking

A didactic, overly controlled (scripted) design process depreciates the value of the intuition and marginalizes the value of a local condition, by imposing an 'a priori' idea or philosophy. While useful in the design delivery, didactic thinking can be derailed by an inability to deal with unexpected incompatibilities. The didactic process alone comes short of creative possibilities because of the inexpressiveness of certain architectural ideas. Also, the true nature of the design process is not deterministic but rather stochastic defined by tendencies and gravitational pulls, not intellectual absolutes.

Any design process needs to have a strong inductive component. This inductive component is responsible for the site response, human experience considerations, as well as formal sculptural expressions that test their appropriateness against human's visual judgment and perception. However, for the inductive design process to thrive successfully, we need to build into it an accident, chance or the unexpected. In the traditional/analog design process we would call it an inspiration. It would usually involve a metaphor, analogy or a set of substitutions, both visual and semantic to facilitate a lateral movement from one idea into another.

Traditional Generative Design Process

This speaks about the continuum between analog creative means and the new digital paradigm. Conceptual design in the traditional design process uses metaphor, analogy, substitutions, and found objects. Found objects can be three-dimensional elements such as ordinary objects, but also a painting or a photograph, sometimes altered in scale or in composition. Oftentimes, designers use destructive or deforming procedures to arrive at new design ideas.

In the design process, a creator is constantly presented with a challenge—how to step outside the familiar and explore possibilities that are not immediately obvious or reachable based on the past experience. This challenge was and is present in design, predating the use of digital technology. However, it is useful to look briefly into the past to see how designers and artists dealt with this predicament to better realize digital tools' impact on the design process. Designers in the past used metaphor, a found object—involuntary sculptures, etc. Dada, Cubism and Surrealism, were good examples of artistic thinking and subsequently were translated into other design disciplines such as architecture.

Found objects, random photographic captures, elements of decay, they all can serve as a diversion and a starting point for design—a seed—that will evolve through a new set of events and follow a new trajectory. While we could discuss more traditional modes of designing; it is important to underline the correspondence of these techniques with digital modes of creativity.

Digital Equivalents and Supersedures

The introduction of digital tools into the design process does not change the rules of the creative game used currently in analog design. Analog tools and methods are easily mapped into new, digital equivalents with little or no translation lost. With the digital design process, analog methods are further expanded by a new set of instructions such as transforms, morphs and substitutions, as well as dynamically changing constraints and sensitivities. These new instructions allow for qualitative change in design thinking and help designers to see their work in new ways.

By deforming, morphing or substituting elements, designers can experiment with models and generate a number of variations that display new spatial and tectonic characteristics. This way of working brings generative qualities into often overly systematic and hierarchical design process by allowing for imaginative design leaps. These generative processes manifest exploratory behaviors and help in pattern breaking out of the current conceptual paradigm—changing a frame of reference. They facilitate idea searching by asking "what if?" questions, not narrowing design possibilities to focus on a final solution as hierarchical processes do. The tectonic products of the generative explorations become the digital equivalents of "found objects," similar in meaning and use as those used by Duchamp in his art[1]. However, it is important to remember that these generative strategies are not means in itself, at least architecturally, but are meant to complement a hierarchical, step-by-step design process.

In the transformation-based approach, the design is executed by applying simple rules and behaviors to the original form. Each of these rules represents a limited vocabulary and produces very recognizable effects, such as the 'bend' or 'twist' transformation. However, by compounding even a small number of simple transformations, the forms' complexity and design possibilities grow exponentially and escape predictable visual patterns (Figures 6,7).

Furthermore, the way a transformation is applied—the relationship between a transformational "gizmo" and the object's axes of symmetry—would result in visually different outcomes. Although, all outcomes would be consistent with a mathematical definition of a particular transformation, they may not be obvious and would be seen as a distinct form (Figure 8).

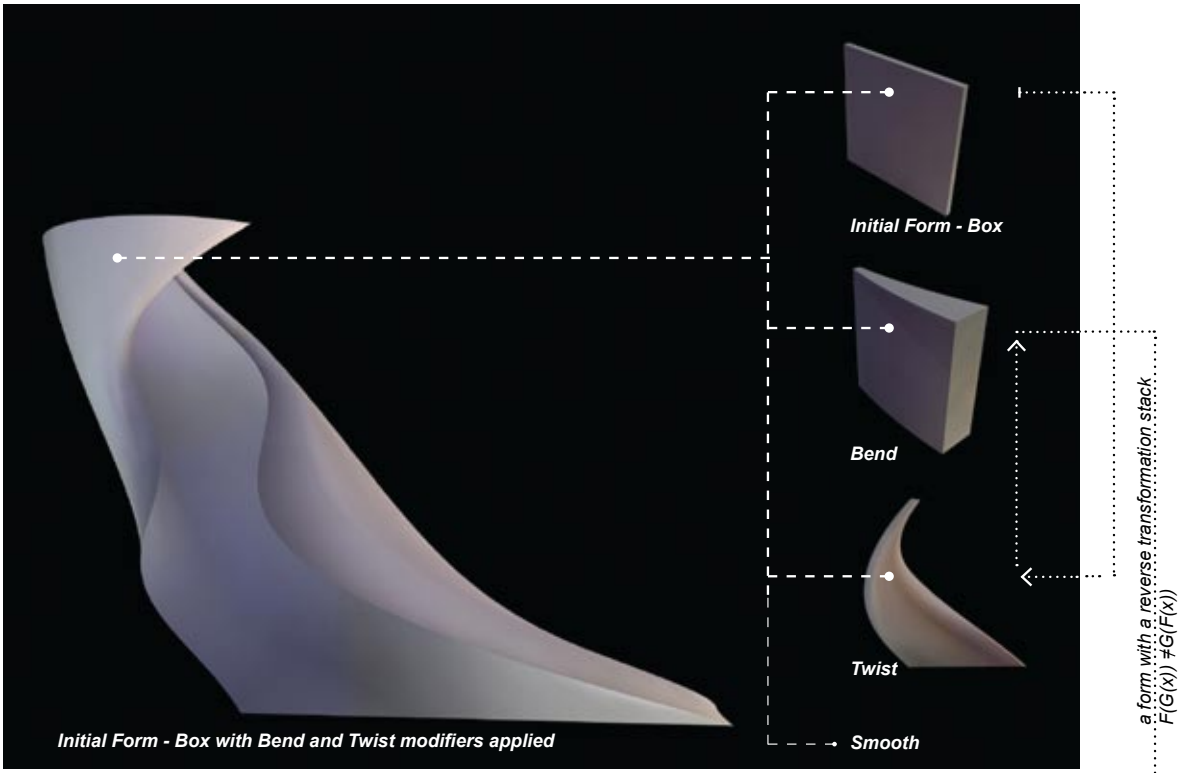


Figure 6: The original cube object with two transformations (Bend and Twist) applied.

Similarly, an internal structure of a transformed object is critical in expressing its resultant form. For example, the bending of a meshed object is dictated by its segmentation. Since individual faces do not bend and are the smallest building blocks of a meshed form, the size and number of segments may drastically change the result of applied transformation. The difference between shapes like a letter "V" and "U" lies in an internal segmentation of an object, not necessarily in the difference of a transformation applied to the letter "I" or a character "-." In these situations, segmentation can be seen as an object's transformational degree of freedom, which defines a number of pivotal points controlling facets and curvatures (Figure 9).

Not only may a transformation result in a new form, but also a change in the internal definition of a form. These changes, when continuous, result in the texturizing of an object, creating an interesting relationship between a form and its texture (faktura). Figure 10 shows form fragmentation resulting in unique material expressions. While animating elements' fragmentations, textual qualities emerge from smooth forms. This also introduces an interesting ability of fragmenting transformations to populate design with newly emerged geometries.

The transformational tectonic strategies show a potential to be dynamic tools in form emergence. Often within a couple of design steps, a form can progress from a seed object to a new, independent creation that does not bear any visual resemblance of the original design.

Figure 7: The same object transformations applied in a reverse order result in a different form.

Script-based or algorithmic design brings this design approach into the next level where a designer sets transformations in a continuous process executed by a script or an algorithm. This algorithm can be completely predefined,

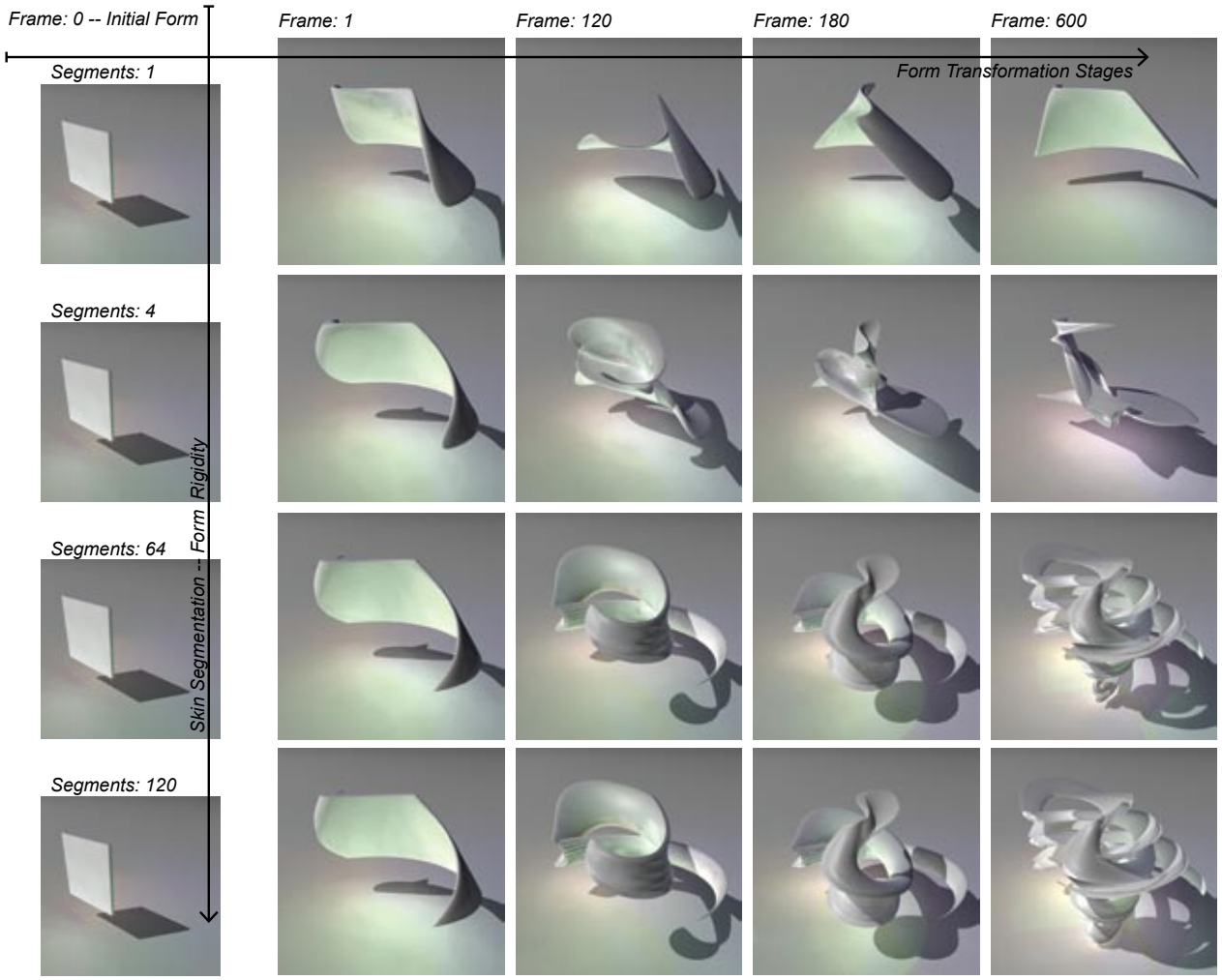


Figure 9: Segmentation as an object's transformational degree of freedom.

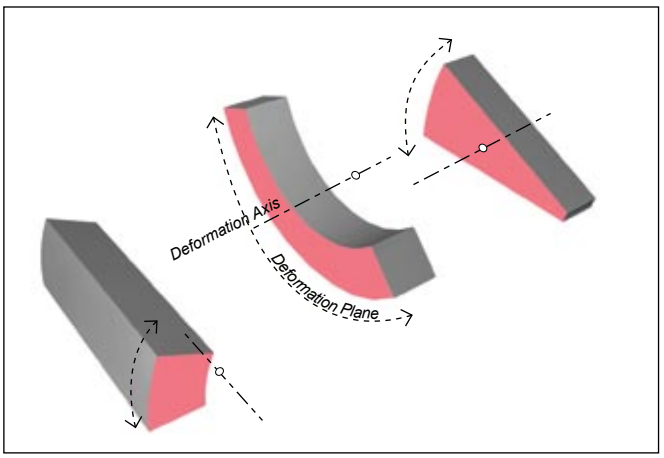


Figure 8: The 'bend' deformation applied along three different axis.

controlled by input parameters, or can have some autonomous behavior based on random variable inputs. These random inputs, further extend the transformation-based or algorithmic design into evolutionary strategies where the design process can acquire some level of self-directing behavior. In this case, the role of a designer would shift from being clearly interactive into a system manager that controls naturally evolving processes through arranging various starting conditions (Figure 11).

For the evolutionary design approach to be successful in creating new ideas and forms, it has to rely heavily on the generative, lateral thinking[2] based design strategies. Since an evolutionary approach uses an existing form as a starting point, the natural tendency would be to continue within its cone default variations arranged within the same family tree. However, a creative process requires transcending its initial state and realization of a qualitatively new form.

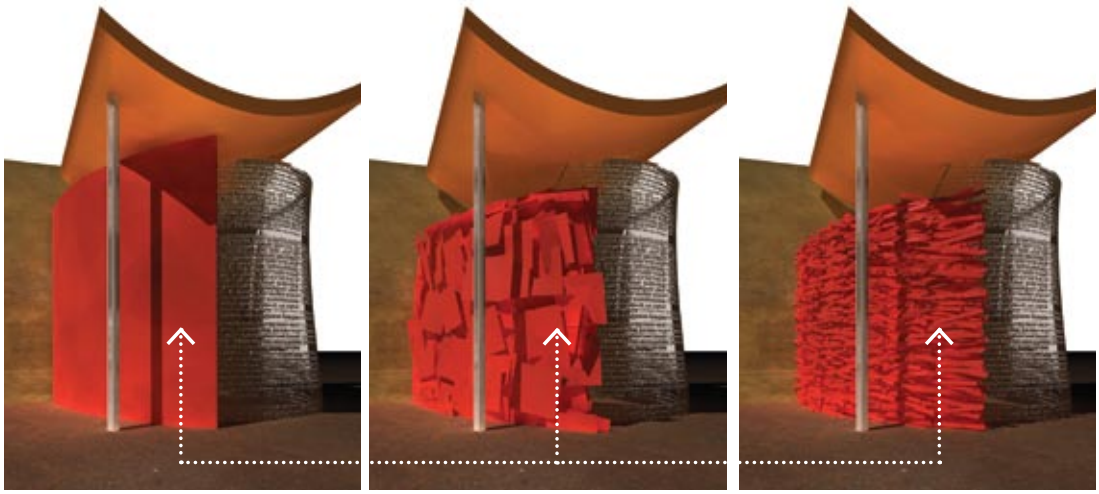


Figure 10: The destructive deformation applied to an object creates an impression of texture. A texture emerges from a surface transformation.

The Design Equation

As one goes through the design process and comes across a difficulty of finding a satisfactory solution, s/he often realizes that the initial assumptions used for design are not compatible with the desired goal. To resolve this situation, one would have to re-address the initial design assumptions. In many cases, it is difficult to evaluate an initial assumption from the perspective of the final design because of the complexity and non-linear nature of the design process. The cause and effect sequence may be obscured, particularly in the analog design process, since there is less opportunities for the common thread connecting various design events.

However, the re-evaluation of initial design assumptions could be achieved by considering design as a formula based equation with parametrically driven definitions and not as a collage of unrelated tectonic gestures. Consequently, if we were to reverse the design direction[3], we could use the final design goal as a driving agent to define what conditions or assumptions are necessary to achieve this specific goal.

Digital based speculations allow for thought-provoking investigations that consequently facilitate looking at the problem in new or less dogmatic ways. Examples of this are tectonic animations used not as generative tools, but as analytical ones to study form potentiality. They help to scrutinize design formula and deriving often-unexamined aspects of architecture.

Since generative digital design can be a product of a parametric formula, we are able to derive any value used in a formula that went into defining this particular form. This is achieved by reversing the design equation and treating the parameter in question as the unknown, while the final design is treated as a variable that informs design assumptions. Consequently, we can ask: “what parameters are necessary to achieve a particular form or performance criteria?” This ability is critical in design evalu-

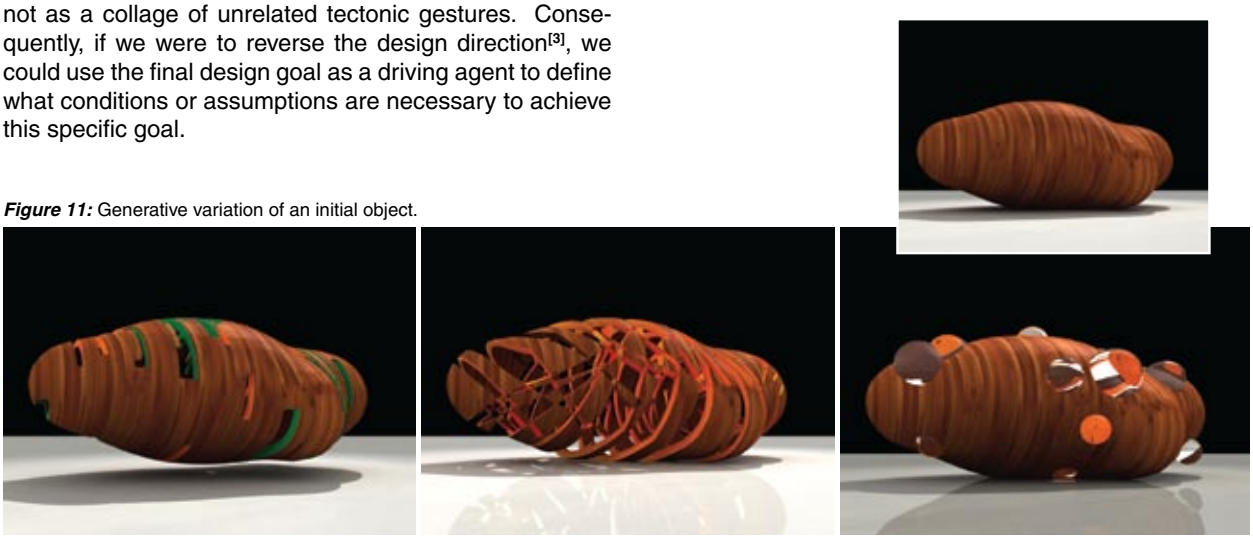


Figure 11: Generative variation of an initial object.

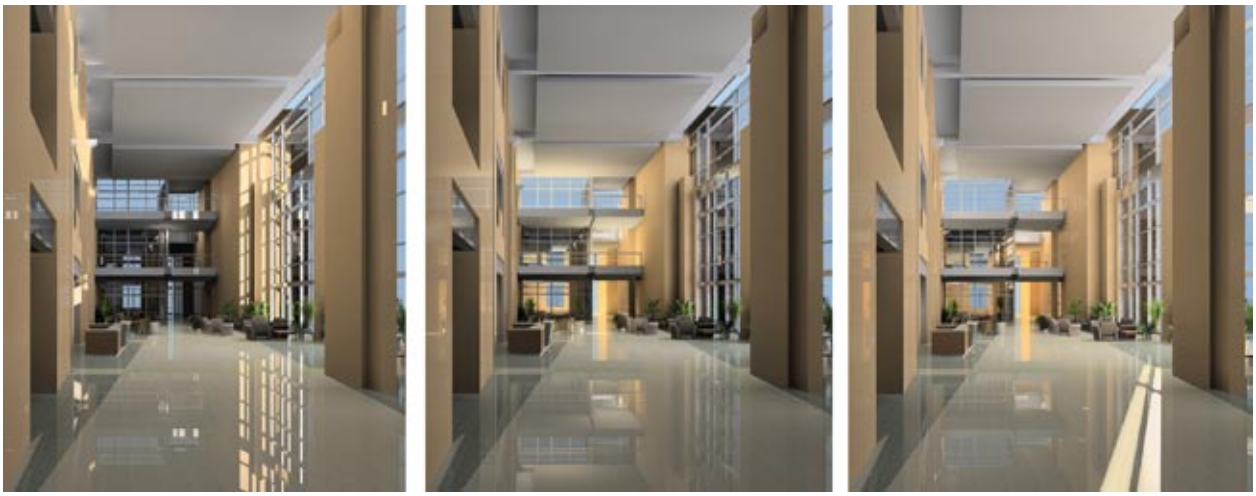


Figure 12: Sunlight study of an interior space.

ation and analysis, since it provides feedback based on final delivery criteria. For example, instead of studying sunlight within a space throughout a day (Figure12), one could study the form as a morphing continuum and pose the question: what a space or form wants to be to allow for optimal illumination, or perhaps more evocative reading of an interior space (Figure13)? This effectively repositions the question from what is the best lighting scenario for a particular design, to what is the design that uses existing lighting possibilities most effectively.

The ability to reverse a design equation and derive a component that is usually considered as unchangeable or constant allows for imaginative leaps. This brings a feedback mechanism into design simulation and allows for a two-directional design process, where the final design can be tested against initial assumptions. Vice versa, a class of possible final designs can be used to verify the integrity of the initial assumptions. Furthermore, this approach promotes creative, non-hierarchical thinking by questioning and testing initial assumptions, which consequently help in overcoming design stereotypes and the inertia of past ideas.

"Why Shouldn't We Undervalue the Digital Design Process?"

As mentioned earlier, the traditional (analog) design process often relies on metaphors or analogies to break away from an established way of design thinking. While this approach is useful in generating new parallel ideas, the product of this analog, generative thinking often does not flow naturally into the next level of design development. While it is very effective in art—the place of its origin, it is more difficult to realize it in design.

An artistically deformed piece of burned plastic may, or may not, easily translate into an architectural form. Its material and texture at the scale of a small, hand-size model may work very well as a design metaphor, but struggles to translate poetically into a full-scale building.[4] This may result in a schism between the conceptual and implemented design manifestations, where poetic visuals cannot be easily translated into architectural forms and propositions.

We often see students creating highly evocative and effective physical study models that later fail to evolve into a more resolved stage. In these moments, evocative conceptual ideas created in early design stages are lost when passed into design development.

The reason for this situation usually does not lie with a student's design abilities, but rather with the non-portability of the design expressions used in this particular model from a perspective of various dimensional scales and detail levels. This lack of portability results from the dependence of their key design expressions on these particular materials, scales or levels of textures. While a cardboard model with partially removed layer of paper looks evocative, this quality may be difficult to express in a full-scale version of the same design.

While both analog and digital design processes are prone to fall into this "lost in translation" condition, I feel that digital generative explorations have a greater ability to transfer the initial intent into subsequent design stages. The reason for the digital design's greater interoperability lies not only in the continuity of digital data sets[5], but also in an ability to go-back-and-forth between the generative and design development model; a stronger interconnection between the design cause and effect. This is particu-

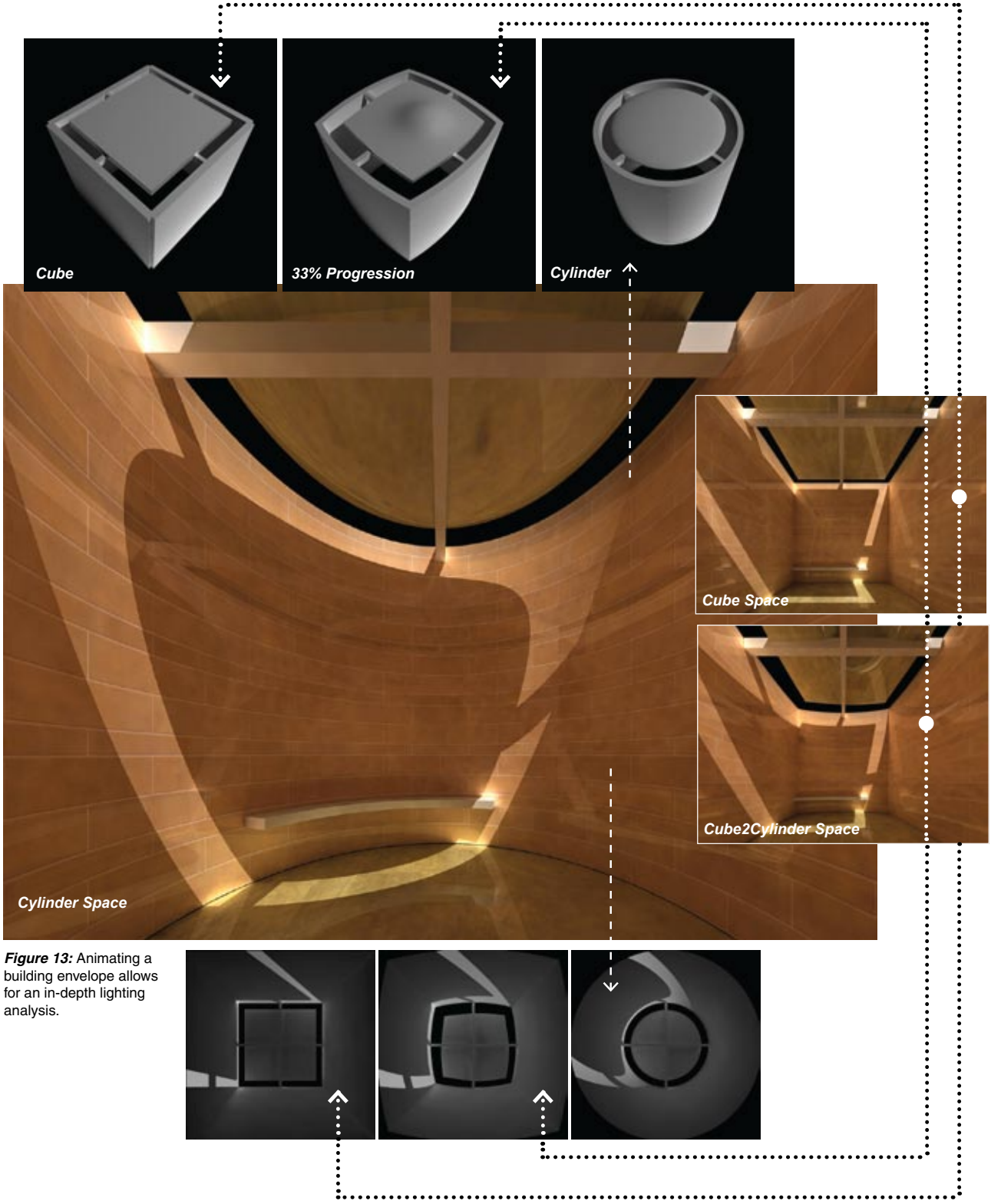


Figure 13: Animating a building envelope allows for an in-depth lighting analysis.

Sun light Shadow Simulation, RCP view

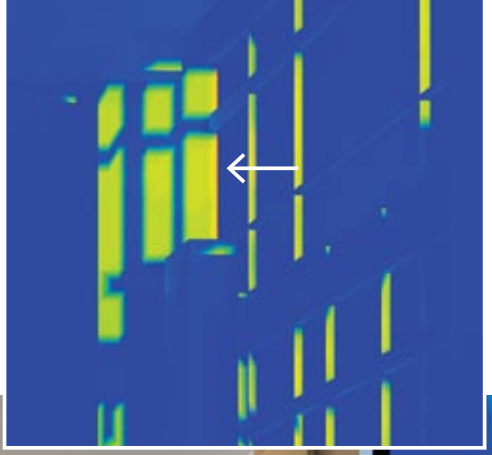


Figure 15: A detail of the illumination analysis showing the change in sunlight intensity when passing through the curtain wall glass.

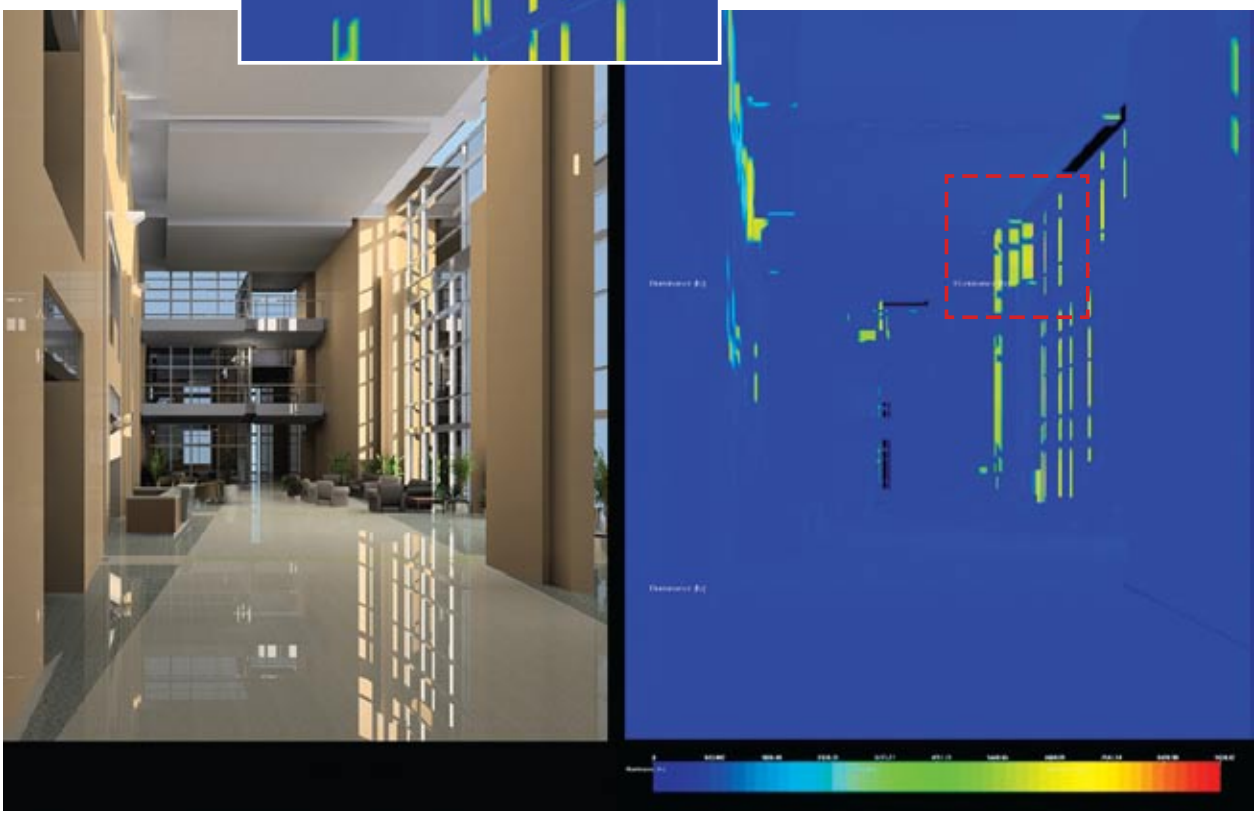


Figure 14: Sunlight illumination analysis module.

larly true in the situations discussed earlier ("reversal of the design equation,") when a causal relationship can be transposed as part of the design evaluation phase.

This continuity of creative expressions compounded through subsequent design phases is more easily achieved within the digital environment than an analog one. The interoperability of digital content goes beyond the ability of various software packages to interact between each other. It is directly connected to design data's spatially and tectonically resolvability as well as digital "lingua franca."

Digital visuals and models have some of the same impediments. However, they can usually be more easily controlled because of the multiplicity of design scales afforded in virtual media. This does not mean that these traditional, highly evocative approaches should not be used in the design process. On the contrary, they should be used as strategic generative devises that help to break away from preconceived patterns, but not as miniatures of a final design.

A critical step in this direction is the development of the Building Information Modeling (BIM)[6], which aims to connect all architectural design stages into one informational continuum spine. This approach has a number of benefits such as error reduction or measures to prevent knowledge loss associated with handing a project from one design team to another. However, it presently operates almost exclusively within hierarchical and sequential paradigms with focus on continuous refinement of design without an idea/design generating component.

While BIM technology starts to address lateral/generative thinking[2] by allowing easy component substitutions such

as window or door blocks, the extent BIM is presently implemented facilitates design refinement more than design explorations. The greatest challenge for the BIM technology is to reconnect its hierarchical and methodological structure with the generative tools like **form•Z**, in order to broaden the tectonic class of solutions, making it relevant with the present state of architectural and product design.

The interoperability between project delivery software (BIM) and design generative software will be critical in achieving a fully integrated digital design process. This would bridge both modes of design thinking—hierarchical and generative—preventing information loss associated with moving between different stages of the project.

More importantly, it would allow instant and interactive design feedback in the conceptual (generative) stages based on the contractibility or building performance criteria. This could be achieved with single or multiple software packages. If done with multiple software applications, it would be important to establish a set of standards or procedures that would facilitate the data portability and interactive building information modeling.

A critical component of this interactivity would be a performance simulation and analysis module (Figures 14,15) that could be used as evaluations criteria for generative designs. With the use of this module, a designer would receive instant feedback on the building's performance, not unlike a player would experience in the game "Jenga," when removing a block from underneath a set of stacked blocks.

Closing Thoughts

With my interest in the geometry of three-dimensional forms, I find tools like **form•Z** very helpful in exploring relationships between various forms and designs. What is most intriguing for me, is not what a particular form with its descriptive qualifications is, but rather how this form can emerge out of another form. With this in mind, the geometry and parametric definitions bring clarity and elegance to the design process. They also allow for greater flexibility in experimentation, which often leads to new qualitative solutions.

This article highlights the often under-appreciated quality of the digital design process; that even though it can be arbitrary and abstract, it also creates opportunities for new modes of thinking and inventing. This quality is directly connected to the digital world's ability to shift scales, substitute elements and to cross tectonic (topological) boundaries. The digital environment is a rich, prolific, generative medium to pursue unintended consequence and achieve unexpected goals. These unintended and unexpected outcomes often fall in a highly desirable class of solutions.

While this article proposes ways to address generative design thinking, it hopefully raises more questions about the nature and structure of the design process. Questions in pursuit of which, will certainly advance our ability to design and create.

Notes

[1] this refers to Duchamp's readymade objects

[2] as defined by Edward de Bono in "Lateral Thinking; creativity step by step"

[3] also called the reverse the design equation

[4] While digital modes of designing are often criticized by its lack of scale and instant zooming capabilities that may confuse designers—there is some weight in this argument; it is often omitted or not realized that the scale relevance of physical models make them often less than ideal study partners since the material, proportional and structural qualities usually do not translate between various scales.

[5] relates to Greg Lynn's "Integration of differences within a continuous yet heterogeneous system"

[6] Although the concept of BIM and similar processes are being currently explored, the term BIM itself is still being debated. Other alternative nomenclatures include: integrated practice/design, integrated project delivery, and more.

Andrzej Zarzycki is Boston based architect and educator who employs building information and generative tools as a common platform for both studio and non-studio courses. His current research focuses on validation methodologies of generative designs through building performance, analysis, and simulation tools. He brings over 10 years of design practice combined with design and technology teaching into the New Jersey School of Architecture, at NJIT. He earned his Master of Architecture from the Technical University of Gdansk, Poland, and Master of Science in Architecture Studies from Massachusetts Institute of Technology, Cambridge, MA.