Design Science

A Framework for Change

Michael Ben-Eli
The Sustainability Laboratory
New York
(212) 772 7592
muben@aol.com
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Purpose of This Document

During the last quarter century, Buckminster Fuller's concept of Design Science has come to mean different things to different people, evolving in the process into a potent combination of method, metaphor and myth.

The purpose of this document is to refocus the concept, address it in the context of some reflections about design in general, and link Design Science to the sustainability challenge facing humanity today.

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1. Reflections On Design

Common Use of the Term "Design"

- The word "design" carries multiple connotations. It is used as a noun, as well as a verb, covering a range of different emphasis and meaning:

  - Preliminary sketch, or plan for making something
  - The art of producing these
  - A plan, purpose, intention
  - A decorative scheme or pattern
  - General arrangement or layout of a product
  - An established version of a product
  - Plan to harm

"Design" – Common, Narrow Focus

- The word is often used with a narrow object related, or professional connotation:

  - A car or a building, as distinct from a planetary system or an ecosystem

  - A designer or architect, as distinct from a doctor, manager or lawyer

- In recent years, however, a broader perspective has been emerging, among innovative design practitioners and others, reflecting a more holistic approach -- a basic tenet of Fuller's concept of Design Science

Fuller's Concept of "Design"

- Fuller used the term "design" to imply a number of distinctive qualities:

    - A sense of an underlying order

    - A "whole," marked by coherence

    - The implied presence of a deliberate intelligence

- He applied the term to a single artifact, to a whole industry and to the universe itself.

For Example:

"Our universe is an extraordinarily automated, fantastic piece of design."

And more :

"Snowflakes are design, crystals are design, music is design, and the electromagnetic spectrum of which the rainbow colors are but one millionth of its range is design; planets, stars, galaxies, and their contained behaviors such as the periodical regularities of the chemical elements are all design-accomplishments."

Some Implications

- There are a number of significant implications to this perspective:

  - Design can involve an active initiative, the shaping of a particular configuration (a particular part of reality)

  - It can relate to a subjective experience as when we recognize order in an observed phenomena

  - It can entail concepts as well as physical entities and combinations of both

The Value Dimension

- Comments on Design Science tend to emphasize the methodology-related aspect of the concept:

    - As a problem solving procedure

    - As a planning tool with a particular critical path (e.g. *the universal requirements for a dwelling advantage*)

- Fuller's concept of Design Science involves another dimension, however, which is based on a whole cosmology and a particular world view:

    - It firmly anchors design to a basic set of all-encompassing values

    - It provides the consistent foundation for an ethics-driven concept of design

- This value driven, ethical aspect is derived from a hierarchy of three concepts that are central to Fuller's design philosophy. They include:

  - Acknowledgement of the mystery and inevitability of an implicated higher order

  - A particular definition of Universe

  - A specific view concerning the function of humans in the cosmic scheme of things

- Such thoughts are rarely part of discussions of design. To Fuller, they provided a source of constant inspiration. They are of enormous practical significance since they demand the question of the driving motivation, the basic purpose underlying design initiatives.

Acknowledging the Mystery

- Fuller joins a tradition of great thinkers which, in modern times, included Spinoza, Newton and Einstein. All acknowledged a higher order underlying Universe and expressed a similar sense of convention-transcending, 'cosmic religious feeling.' For example:

> *"…all things which are made, are made*
> *by the laws of the infinite nature of God,*
> *and necessarily follow from the necessity*
> *of his essence."*
>
> Baruch Spinoza

"The order that reigns in the material world indicates…a will that is filled with intelligence."

Isaac Newton

"That deeply emotional conviction of the presence of a superior reasoning power, which is revealed in the incomprehensible universe forms my idea of God."

Albert Einstein

"Human mind has experimentally demonstrated at least limited access to the eternal design intellectually governing eternally regenerative Universe."

Buckminster Fuller

- This deep personal conviction constitutes the basis for an argument which runs as follows:

  - Universe is a dynamic, forever regenerative, unfolding scenario of inter-transforming, non simultaneous events, suggesting an immanent order

  - This order is expressible as generalized principles all of which synergetically inter-accommodate

  - These are accessible to the human mind which is able to discern and express such principles as consistent patterns in an accumulation of special case experiences

- Employing universal generalized principles is critical to human's anti-entropic ability to construct and optimize favorable, orderly, local configurations

- Humans, their thoughts, activities and designs are inseparable, active components of the very dynamics of cosmic evolution

- All the forgoing imply a moral obligation to ourselves and to the ancient Universe of which Earthians are only a very recent part

- The obligation is to utilize our best and unique faculties and employ Nature's principles in ever better designs, on behalf of all humans and the whole planet

Defining the Term "Design"

- The view of Universe as a non-simultaneous, kaleidoscopic flux of constantly inter-transforming events means that "reality" continuously reorders itself.

- Two points are significant, in this respect, to defining the term "design":

  - As already argued, human activities are a part of this broader self-organizing process

  - Generating order, in some particular sense, is at the heart of the idea of design

- Fuller, for example, talked of design as the "deliberate ordering of components."

- "Deliberate" implies the crucial presence of purpose, suggesting that the essential characteristics of purposeful processes offer the necessary elements to a fresh definition of "design."

- Purposeful processes, in general, involve a series of steps moving from an initial intention to ultimate realization — a sequence typical to the process of manifestation.

- In the broadest sense, design underlies all manifestations. I would offer, accordingly, the following definition:

Design is the Process of Realizing Intentions

- There are three active components in this definition:
    - *An **intention**:* Crucial to the triggering of any action but, in itself never enough
    - *An **action**:* As in "reduction to practice," which for any effective realization is always a must
    - *A **process**: S*tages, or steps over time which link the two, transforming an intention to an actual realization

- As a starting point, intention is always paramount. It constitutes the basis for ethics and is, ultimately, the window, the link to the divine.

Design – Concept or Action?

- Design is often referred to as the specific, conceptual phase in the progression from an intention to realization. The definition offered above embodies both concept **and** action in order to account for the following:

    - At times, conceptualization and execution are fundamentally simultaneous (in calligraphy for example)

    - Action is clearly required in the construction and testing of models and actual prototypes that are an integral part of the design process

    - From the perspective of an expanded time frame, conceptualization and action are always intertwined in the long term process of refinement, adaptation and change

- Action is the root of experience. It is an aspect of how Universe manifests itself. As otherwise expressed:

    "Action is the product of the qualities inherent in nature."

    The Bhagavad-Gita

Manifestations of Design

- Manifestations of designs generated by humans are manifold, rich and hugely diverse. They vary with the particular context. Each such context is characterized by its own specific vocabulary and syntax, the different sets of "building blocks" and rules of engagement, that are in use.

- Design thus applies to all (as well as to combinations) of the following:
    - Objects
    - Concepts
    - Events
    - Visual or audio patterns
    - Organizations, institutions and social frameworks of any kind
    - One's own life

- From this broader perspective, all forms and expressions of human activity are manifestations of design processes. By our very nature we are all designers, all active participants, agents in the unfolding designs of evolution itself.

Synthesis, Analysis and Quality in Design

- Design is fundamentally an integrative process involving the synthesis of elements into a coherent whole. Synthesis is paramount. It involves the intuitive ability to see the possibilities of novel combinations. The initializing role of intuition and imagination are crucial, as was clearly recognized by Einstein when he wrote:

    "Imagination is the beginning of creation."

    And more:

    "Imagination is more important than knowledge.
    Knowledge is limited, imagination encircles the world."

- Superior design reflects the integrity of means, execution and purpose. It resonates with and stirs the soul, to the extent that it approximates the complete satisfaction of a combination of basic human needs encompassing the physical, emotional, intellectual, and spiritual dimensions.

- The integrity and coherence of the whole, whether in painting, music, a building, a mechanical device, or a social process, is then mirrored in a sense of satisfaction and recognition of beauty:
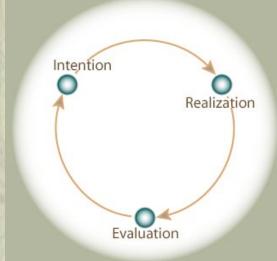
  "When I am working on a problem, I never think about beauty. I think only on how to solve the problem. But when I am finished, if the solution is not beautiful, I know it is wrong."
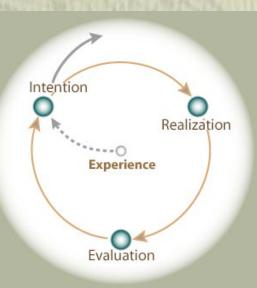
  Buckminster Fuller

- Invariably, a balanced combination of the intuitive and the rational, the heart and the mind, of art and science, is ultimately essential for excellence in design.
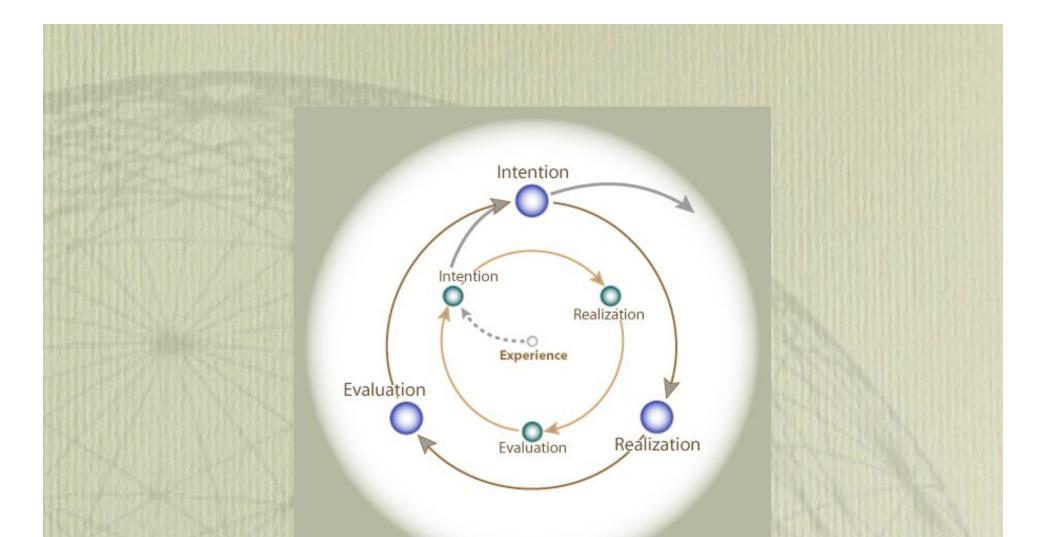
Anatomy of Design Processes – The Universal Design Spiral

- The basic formal structure of a purposive system underlies the process of design. It involves a dynamic circular structure, integrating a goal with activities aimed at attaining the goal, and a facility for evaluating the results.

- Substituting "Intention" for "goal" and "Realization" for "activities aimed at attaining the goal," such a circular sequence provides the basic building block of the design process, as depicted in the drawing.

- The possibility for learning, adaptation, and the kind of shifts that are involved in an evolutionary expansion of context, requires that each such circular closure be opened to the next more encompassing cycle of integration. In the diagram below, the arrow exiting "Intention" initiates progression to a new, "next level" cycle, when, with a changing context, the goal and all other related aspects must change.

- The process as a whole can thus be envisioned as an expanding spiral incorporating progressive sequences of the key steps comprising the design process, along its path. The particular quantity which is expanding over time is **Experience.** In the process, it becomes ever more inclusive, comprehensive and "wise."

- Experience itself, always provides the context and the starting point for every cycle of design. Hence the fundamental requirement for experiential verification, the essence of the scientific method.

The Universal Design Spiral with Two Cycles of Expansion

Experience: The Link to "Source"

- The Universal Design Spiral is rooted in experience. It is from experience that intention springs. Experience itself is integrated through a number of distinct, interacting levels including:

    - The accumulation of direct, personal life experiences

    - The evolutionary experience of a specie, as coded in the gene pool

    - The psycho-cultural experience of society as embodied in its particular history and in the kind of archetypes described by Carl Jung

    - The cosmic experience as embodied in the very structure of matter

- In the broadest sense, experience provides the link between the special case and the general, the individual and the cosmos, the particular designer and an expanded matrix of being.

Stages in a Generalized Design Process

- A complete design process comprises a number of distinct phases, or steps, each incorporating a cluster of a different type of activities. Five essential steps appear to be consistently involved along the Universal Design Spiral. They Include the following:

    - Intention
    - Formulation
    - Realization
    - Operation
    - Transformation

- **Intention:** This is the initiating step. It may emerge with a vague recognition. It represents an initial impulse, a hunch, an inspiration — before analysis or a fully developed rational argument. It is largely intuitive and is essential to the initial energizing of motivation. It springs from a cumulative synthesis of all previous experiences.

- **Formulation:** This phase involves the increasingly sharper formulation of a concept. The focus is on a defining a purpose, a galvanizing vision, a mission, a strategy, an approach. Early rounds of research and analysis are involved in articulating and shaping all of these. A plan, a program, a detailed blue print, is the end result.

- **Realization:** In this phase, the conceptual blue-print drives a reiterative process of modeling, prototyping, testing, refinement and debugging. It culminates with the production, construction or other forms of implementing a new design.

- **Operation:** This phase moves from implementing a concept to all the aspects associated with routine use. Issues of maintenance, service, recycling and the like. Where relevant, it also involves incorporation of adaptive refinements following actual experience with use.

- **Transformation:** This step represents a discontinuity relative to a given design cycle. A new intention emerges in response to fundamental change in the context and a new cycle begins. Unlike changes which characterize adaptive refinements, where despite a series of improvements and adjustments the general framework remains unchanged, this step represents a major shift, a clear break from the past. For example, a shift from a horse drawn carriage to a motor car, from wire to wireless technology, from surface to air transportation, from an agrarian to an industrial society, from classical to modern painting, or from centrally planned to free market economy.

Additional Aspects of the Design Process

- Bearing in mind the general model of the Universal Design Spiral with its five essential steps, a number of additional characteristics define the design process:

  - The process is **adaptive**, meaning that elements in all of the five essential steps continuously co-define and inter-accommodate, in relation to each other and with respect to the context as a whole

  - The process is **reiterative**, requiring continuous adjustments and re-adjustments as advances are made at each step

  - The process is **recursive**, meaning that a similar circular structure that characterizes the whole reappears within each one of the individual steps

- A few additional comments about aspects of the design process are instructive:
  - The recursive aspect, often a source of confusion, is of important logical and practical significance. It means that "purpose," for example, requires formulation and reformulation with each step, where it is articulated in a manner appropriate for that particular step. It would thus be defined at different levels: as a general intent; as a particular objective; as the guiding essence of a strategy; and, as the series of specific goals necessary for implementation.

  - The design process as a whole is often represented as a sequence of clearly differentiated logical phases. In reality, it operates more like a non-sequential network of dynamic, self-organizing, multiple, interacting events.

  - The process can be instantaneous or it may need to be organized over a considerable period of time.

- The process may involve a single individual or it may require the integration of multiple teams representing, at different stages, different capacities and expertise. The later raises the issue of effective management of the design process as a whole.

- Finally, a point that is all too often neglected particularly in broader socio-economic aspects of human affairs, namely, that the design process, for each given case, needs to be the subject of deliberate design in itself.

Why Endeavors Fail?

- Design initiatives can be demanding. Intentions do not always culminate in complete and satisfying realization and even well intended endeavors fail. Why?

- A comprehensive view of the essential elements along the path of the Design Spiral, and the way they inter-relate, suggest a set of universal reasons:

    - The underlying motivation may be impure
    - The driving vision may be blurry, or irrelevant
    - The purpose may be unfocused
    - The strategy may be faulty
    - The execution may lack capacity
    - Communication channels between distinctive steps may be clogged, noisy, or entirely missing
    - Internal conflict may exist between key elements and the whole may not cohere

2. Design Science

"…The effective application of the principles of science to the conscious design of our total environment in order to help make the Earth's finite resources meet the needs of all humanity without disrupting the ecological processes of the planet"

Buckminster Fuller

The Concept of Design Science

- Buckminster Fuller coined the term *"comprehensive anticipatory design science"* in order to characterize his unique design philosophy. He applied the term to the following:

    - The process of inventing and developing his own particular artifacts

    - As a more general, radical concept for a total redesign of the world's industrial infrastructure

    - To the speculative thinking about humanity's own ability to actively participate in shaping its own evolution

- With the concept of Design Science Fuller introduced a rigorous, science based design approach to the world of Architecture and built structures, to which he referred as "environment controls."

- His approach was influenced by design, production and planning experiences in 20th century industry, primarily in shipping and aviation, involving concepts and criteria not common at the time in the building sector, which he saw as a throw back to the pre-industrial world.

- Over time, design science has emerged as a practical framework for processes of innovation and planning. It is as relevant to product development or building design as it is to addressing the broader, collective issues facing humanity in the twenty first century.

- A number of essential points are at the heart of Fuller's particular perspective:

    - Emphasis on the need, and possibility, for applying a deliberate design approach, rather than relying solely on evolutionary haphazardness, to human affairs

    - Projection of the concept of Design Science as an "objective," applied discipline integrating architecture, industrial design, engineering, and all other sciences

    - Focus on application of the highest potentials of science and superior, appropriate technology to the intentional advancement of well being and standard of living of all

    - Emphasis on deliberate deployment of generalized principles in organizing the basic components of the physical world into consecutive waves of increasing advantage-yielding combinations, as distinct to mere political reform

    - Emphasis on demonstrating tangible results through the reduction of design concepts to actual practice

    - A planetary perspective on an integrated, option-expanding, life-support infrastructure, coupled with an emphasis on individual initiative in enhancing its scope and potential

Key Elements in the Design Science Approach

- A few distinctive elements characterize the Design Science approach: as a process, it is comprehensive, driven by whole system thinking; it is anticipatory and future oriented; it is aligned with nature, reflecting nature's underlying principles; and, it is science based, subject to rigorous testing and empirical verification.

- These essential features are captured by the full designation "Comprehensive, Anticipatory, Design-Science" where each term, in turn, conveys a crucial aspect of the approach as a whole.

Comprehensive

The term *"Comprehensive"* puts emphasis on the need for taking a whole system perspective in dealing with an integrated, complex world. A few ideas are important in this regard:

- The shortcoming of narrow specialization and dangers inherent to fragmentation require that exploration and development strategies begin from the broadest possible perspective, arriving at parts from a concept of the whole. The underlying reasoning stems from the concept of synergy and the fundamental unpredictability of whole system complexes, by the behavior of their parts alone.

- From the view point of system thinking, the challenge of comprehensive design lies in addressing the relationships between wholes and their parts, identifying the interactions between all the relevant parts, and understanding the consequences of these interactions.

- From the perspective of synergetic geometry, the simplest possible whole system is represented by a tetrahedron (a four faced triangular pyramid) which divides the universe of possibilities into three: everything outside of the system; the system itself; and, its internal configurations. The consequence is that every design problem needs to address and integrate, in one continuum, three essential dimensions: the system under consideration, its context and, its internal components.

- One particularly significant challenge offered by Fuller's comprehensive perspective pertains to his concept of "space ship earth" and his vision of the planet itself, as an object of conscious, holistic design.

- On a different level, "comprehensive" requires not only incorporating all the critical variables, but also addressing the issue of complete life cycle, for each design case.

Anticipatory

The term *"anticipatory"* highlights the proactive element of the Design Science approach. It calls attention to the need to consider the likely direction of underlying conditions, as a key element in formulating new designs.

- The emphasis is not so much on "predicting" the future as it is on identifying, researching and interpreting significant trends in order to gain a deeper understanding of a likely course of events.

- The focus is on apprehending the underlying factors which influence outcomes, so that these can be taken into account when options are considered and choices on actions are made.

- The anticipatory stance is required in specifying the eventualities under which a given design will have to perform. It comes into play in three essential ways:
    - As a means of obtaining clues for guiding the effective maintenance and improvement of existing configurations and conditions.
    - As a means of foreseeing and preparing for possible adverse impacts of undesirable events
    - As a stimulus for formulating desirable future conditions – preferred states – as projected ideal outcomes representing a break from the current and past

- The concept of "preferred states" is key to the Design Science approach. It takes the idea of problem solving beyond the calculus of risk and into the creative realm of imagining entirely new possibilities.

  - A preferred state is formulated as an ideal outcome representing a projected, most desirable result

  - The focus is on optimizing a future condition rather then on existing constraints

  - The working procedure is to back-cast from the projected to an existing state, then, developing the steps that are necessary for attaining the idealized goal

- The concept of preferred states carries another connotation for the design process: an ideal state may be defined as a general condition rather then as a precise end point. In such a case an adaptive, self-organizing, "becoming-as-you-go-process," would be the most appropriate approach.

Design-Science

The combined term *Design-Science,* refers to the process of deliberate ordering of components in the creation of a new configuration assembled for achieving a desired goal. In this case, the focus is on supporting the process of creation by effective employment of generalized principles derived by sound science:

- The challenge is posed as de-emphasizing habits, or mere fashion, as the primary shaping forces of the design process

- Instead, the emphasis is on distilling and manifesting generalized principles in a process of achieving progressively higher advantage, with benign, ever-decreasing-in-quantity, use of resources

- Looking to science for providing a guiding framework for design means all of the following:

    ▪ Seeking inspiration from nature and her economic, elegant, intelligent and integrated ways of accomplishing her myriad expressions
    ▪ Encouraging an active, open minded process of exploration and admission of error as a necessary element in the creative design process

- Employing general principles which govern special case experiences as the primary, enabling factor in driving design and defining the real range of ultimate limitations.
- Modeling the design process itself on the scientific method with its cycles of explorations, generation of hypothesis and rigorous verification by actual experience.
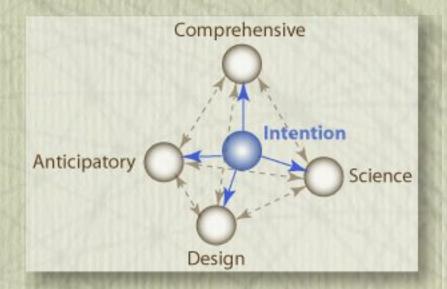
- In summary:

Comprehensive Anticipatory Design Science incorporates a number of key concept that are rarely integrated in the ways we address human affairs. If employed effectively, it can provide a coherent framework for realizing a combination of ethics, aesthetics and superior performance in all design undertakings.

What is Unique About Design Science?

- A systems perspective, anticipation of critical eventualities and a design driven by fundamental principles of science are all at the heart of myriad technology projects in space exploration, nuclear weapons development and many more. What, then, is unique about Design Science?

- Ultimately, the uniqueness lies in the underlying purpose – the question of what are we designing for. With that question we are led back to the basic issue of intentionality. To Fuller, the answer was always clear: the one purpose of Design Science is to employ resources and generalized principles, so as to render 100% of humanity successful without doing harm to other vital components of the biosphere.

- This clear, simple, direct, and singular purpose coheres the whole approach and provides its center of gravity. Borrowing on one of Fuller's favorites, the Tetrahedron, the idea can be portrayed in the image depicted below:
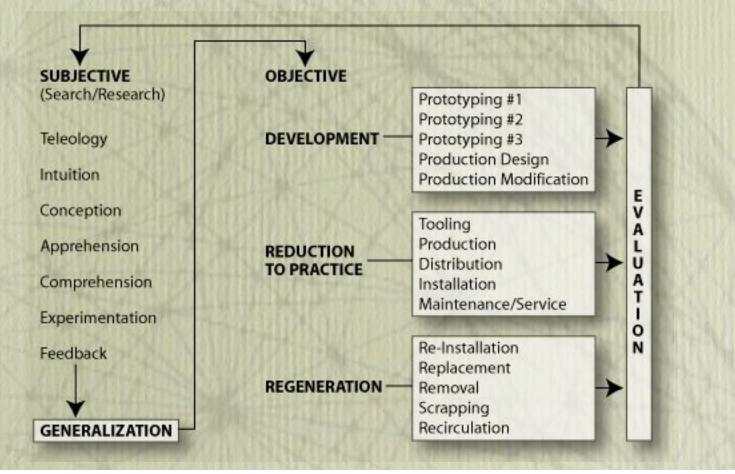

- Intention can be quite elastic, ranging along a wide spectrum from the narrowest ego-centric focus, to an increasingly broadening horizon of inclusion and concern. Design Science encourages an all inclusive perspective aspiring to the achievement of the greatest possible, long lasting advantage for all.

Additional Aspects of the Design Science Approach

- A number of additional aspects are inherent to the Design Science approach:

  - The use of visualization technology as a means of exploring and sharing data, and enhancing analysis and understanding.

  - The use of simulation techniques as a tool in trends exploration, evaluating options and testing proposed approaches.

  - The pedagogical aspect of creating environments in which group learning about planetary issues is greatly enhanced.

  - The use of the process as a means of facilitating collective creativity and stimulating and amplifying the collective intelligence of participating groups.

The Design Science Event Flow

- Fuller's original Design Science Event Flow is depicted below. It pertains to the development of an artifact, in this case a dwelling machine. It provides the conceptual framework for an extensive critical path, his "Universal Requirement for a Dwelling Machine."

SUBJECTIVE
(Search/Research)

Teleology

Intuition

Conception

Apprehension

Comprehension

Experimentation

Feedback

GENERALIZATION

OBJECTIVE

DEVELOPMENT
- Prototyping #1
- Prototyping #2
- Prototyping #3
- Production Design
- Production Modification

REDUCTION TO PRACTICE
- Tooling
- Production
- Distribution
- Installation
- Maintenance/Service

REGENERATION
- Re-Installation
- Replacement
- Removal
- Scrapping
- Recirculation

EVALUATION

- The flow chart comprises essentially four major steps: Special case, subjective experiences are abstracted into generalized principles which find their expression in objective employment in a particular design (1). The particular design solution then goes through a process of testing, prototyping, and refinement (2), before reaching the actual reduction to practice phase, involving production and use (3). There follows the next phase of replacement and recirculation (4). Each step in the sequence is subject to a process of evaluation, an activity which closes the loop.

- Complex, technical critical paths and the art of such management control techniques have evolved significantly in recent years. Some science and technology projects incorporate virtually millions of steps, with zero error-tolerance, a critical need to anticipate all possible eventualities and the inclusion of essential milestones for which basic science may not yet exist at the time when the project is launched.

- Perhaps Fuller's most radical contribution, however, can be found in his idea of applying the rigor of a critical path in a deliberate effort to reconfigure the world's industrial infrastructure so that it yields an amplified omni-advantage for all.

Design Science as a Practical Tool for Innovation and Planning

- Fuller's many pronouncements on Design Science and his Design Science Event Flow, in particular, are focused on the development of artifacts: structures, machines and whole systems of reciprocal, interacting inventions. Ideas inherent to the approach are applicable, however, to a broader context including the design of social processes and institutions, and the wider domain of evolutionary issues where social systems and technologies are inexorably combined.

- The approach offers a powerful discipline for driving innovation and planning in general. It provides a practical tool, a comprehensive guiding framework which can assist individuals and groups in developing, testing and selecting among alternative paths, as they create a desired future.

- As a process, the approach can be tersely expressed by a generic sequence of 12 interrelated steps each representing a spot on one complete cycle of the Universal Design Spiral. Each cycle comprise the following steps:

  - *Pay heed to the whispers of intuition*
  - *Articulate a purpose*
  - *Identify, research and synthesize all issues that are relevant to achieving the purpose*
  - *Project and refine a vision of a preferred state*
  - *Re-frame the key issues and develop performance criteria*
  - *Incorporate advantage amplifying first principles in driving an initial design*
  - *Refine the initial design through repeated cycles of experimentation, testing and improvement*
  - *Settle on a finalized design*
  - *Expand the plan to address all the necessary implementation considerations*
  - *Implement the optimized, test-proven design*
  - *Secure effective management of all relevant operations throughout the complete life cycle*
  - *Remain sensitive to new evolutionary changes in the context and prepare for a new cycle requiring a paradigm shift in the implemented approach*

- As guides to design, prescriptive linear check lists, such as the one provided above, can be grossly misleading in their simplicity. In reality, steps overlap and processes are parallel and reiterative. As in a rich eco-system, elements in the sequence interact through multiple loops, adjusting, co-defining and adapting as the whole process unfolds. These essential, dynamic characteristics need to be incorporated in laying out the design process itself.

- Furthermore, genuine innovation and creativity are often required at each step on the way. Neither can be mandated or prescribed. There is an elusive quality to the creative process that is essential to superior design. Legendary jazz idol, Louis Armstrong, expressed it best:

  "It don't mean a thing, if it ain't got that swing…"

In Closing

- Design Science offers a sensible framework for addressing design issues at various scales. It incorporates a noble purpose with a comprehensive system perspective and some guidelines for effective rigor in problem solving.

- It should not be taken as a rigid universal prescription, a cook book recipe for automatic, mindless application, or an object for cult following. These are contrary to the fundamental premises which are at the heart of the approach: continuous questioning, exploration, independent thinking, and individual initiative.

  - Each design problem comes with its own unique context and posses its own unique requirements
  - Each generates its own questions and its own criteria for success
  - Each brings forth its own cluster of technical questions and its own critical path

- Design Science, in itself, does not solve, create, or resolve. It is each unique application of the ideas immanent in the approach which make the difference. Ultimately, resolving each specific design initiative must be left to the unique integrity, enterprise and creativity of the individual, group, or community involved.

3. Sustainability:
The Ultimate Design Challenge

Designing the Next Evolutionary Step

- Transforming the world's economy to a sustainable basis and establishing the concept of sustainability as the organizing principle on our planet, represents the most significant challenge of our time.

- This challenge is unprecedented in scope. It requires a fundamental shift in consciousness as well as in action. It calls for a deep transformation, simultaneously, in all aspects of human activity including our world view, our values, our technology, current patterns of consumption, production, investment, governance, trade, and more.

- The ultimate goal of the required transformation is to foster a well-balanced alignment between individuals, society, the economy and the regenerative capacity of the earth's life supporting eco-systems. This balance is currently greatly disturbed.

- In spite of growing awareness and a swell of recent efforts inspired by the sustainability challenge, progress remains sporadic, and painfully slow. Key elements of the biosphere continue to deteriorate as a result of expanding human activity. As signs of stress continue to mount the need for a deep transformation is becoming increasingly urgent.

- Many tools, instruments, mechanisms, institutions and frameworks that are currently employed – our technology, the basic configuration of the industrial infrastructure, the accounting system which drives the economy, existing systems of governance, the mental models and values which dominate our culture – are inadequate to the task.

- Most of these have evolved in a past characterized by physically remote groups of essentially fragmented humanity, motivated by fear of scarcity and the dominance of brute force. Most are unsuitable for the collaborative effort required in constructing a wise, prosperous and peaceful planetary civilization.

- Attempts at converting to sustainability practices often fall short of the required shift since most initiatives conform to existing paradigms and are largely formulated within the prevailing frame of reference – precisely the framework that needs to be changed. Mere adjustments will not be sufficient. In this case, the system itself must change.

- Industrialization, which propelled developments on the planet during the last few hundred years has matured. It is completing its cycle on the evolutionary design spiral. Humanity is now perched on the threshold of another historical shift which calls for a fresh, new planetary paradigm.

- Great historical transformations have occurred in the past. A change from hunting and gathering to an agrarian economy; the rise of urbanization; the industrial revolution; are familiar examples. All had long periods of time to evolve. Time, however, is of the essence at this juncture. This will require a conscious, deliberate, concerted effort, of an entirely unprecedented scale.

- With the concept of Design Science Fuller anticipated the essence of the required transformation. He called for a design revolution as a means of realizing the necessary change. The purpose, the planetary perspective and other key aspects of the Design Science approach are still absent, however, from mainstream councils of world affairs and the way global issues are handled.

- Contrary to the basic tenets of Design Science, prevailing practices consistently betray the following characteristics:

  - They react to events rather than be guided by proactive anticipation of trends

  - They take a fragmented, narrow-interest driven perspective, rather then a comprehensive, whole system view

  - They rarely address major issues with a coherent design approach

  - They allow science to be treated as an afterthought in a largely political process

- Yet, if humanity tackles the challenges of the sustainability transition successfully, it will be because the next decades will have witnessed broad based adoption, mastery and practice of the Design Science approach with introduction of sustainability principles as the driving performance criteria in design.

- Nations may not yet be ready to join and truly cooperate in such an endeavor. They may be increasingly forced to collaborate as crises exacerbate, but under crisis conditions wise council may not always prevail. Multiple other initiative should be, therefore, encouraged until a critical mass triggers a virtuous expansion leading to the desired shift.

- Design Science can play a crucial role in mobilizing humanity for action. It can help inspire and energize motivation; offer a conceptual framework for exploring creative new ways; and provide the discipline essential for realizing effective change. It can be employed to foster the proliferation of change agents who will collaborate in integrating myriad sustainability related initiatives into a coherent critical path.

- Networks of Design Science Centers can be established in all parts of the world in order to accelerate, coordinate and amplify multiple transformations to sustainability practices. Leveraging the appropriate technologies, an interactive, world-wide, on-line conversation can be ignited, with millions of participants involved in articulating preferred states and creating a marketplace for breakthrough innovations.

- Our species appears to be poised at an historical crossroad. We are offered a choice to evolve and claim a new paradise, or slide in a painful ride to oblivion. Consciously reaching for the sustainability option and realizing its promise has become a moral imperative. A challenge we dare not fail. It is the ultimate design challenge.

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Michael Ben-Eli
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