Diagrams of the Design Process

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Abstract
In order to satisfy the new challenges of designing- in respect to sustainability, nature, economics, politics as well as social-cultural concern- it is necessary to establish more efficient ways to design, not haphazardly, but consistently seeking adequate design solutions.

Suggestions for a creative design process span from a very detailed and precise sequence to no process at all. Included are various sub elements of the design process, such as creativity and thinking styles. Various designers were requested to draw a diagram of their individual design process in an attempt to capture more precisely the nature of the design process. Interestingly, the results reveal that drawing is an essential tool in understanding the design process, because drawing a diagram of the individual design process tends to encapsulate the design process where verbal expression remains imprecise and censured.

Diagrams of the Design Process

I would like to take a quote from Albert Einstein as my point of departure:

The formulation of a problem is far more essential than its solution.
(Hanks, Belliston, Edwards 1978 (a): 94)

It seems to me that one of the challenges in designing today is to understand how to formulate the nature of the creative design process. If we can arrive at a clearer, more methodical understanding of the design process, then presumably we can stimulate greater creativity for ourselves and our students, thereby arriving at a blueprint for solving any type of design.

Not all designers are interested in learning about the design process, nor do all consider it helpful to be conscious about the process in order to design more effectively. Some designers resist investigating the processes, claiming that the analysis will stifle creativity:

If you call it, “It’s a Good Idea To Do”, I like it very much; if you call it “method”, I like it but I’m beginning to get turned off; if you call it ‘Methodology’, I just don’t want to talk about it.
(Alexander 1971 (a): 3-7)

The history of past inventions suggests that the inventive element of design may be independent of possessing expertise, whether in the design process or in the field of production. For example, kodachrome films were invented by a musician, ballpoint pens by a sculptor, and pneumatic tires by a veterinary surgeon. Moreover, a problem peculiar to design is that improved or ‘better’ design is often a matter of personal opinion, making it difficult to establish standards and techniques for any one design process:
Nor is design only concerned with objects, it is equally concerned with establishing the most functional way of doing something; for example, the sequence of steps involved in the check-in procedure at the airport.

...design methods are intended for the design of...‘the total situation’...meaning the functions and uses of things, the ‘systems’ into which they are organized, or the ‘environment’ in which they operate...the operating wholes of which modern life is being formed and made: traffic systems, computer software, educational programs, hypermarkets, etc. This is the scale of design today.

To design is to identify a problem, and seek solutions. Constant evaluation, conceptualization and decision-making precede the final choice, which can be one of many possible solutions. The entire process could be called the act of creatively compromising conflicting factors. Overall, it advances from abstract considerations to more concrete ones, but essential to the whole process, as Asimov saw, are the numerous ‘feedback loops’, the relationships between the different phases in the design process that arise in adaptation to new information or obstacles. (Rowe 1987 (a): 47)

For instance, Hanks considers that the design process consists of spiral methods of thinking:

... the thinking goes in a spiral and never ending pattern solving one problem after another. Constant research, understanding, goal setting, action, and evaluation form the spiral process of thinking. A designer is forever expanding his understanding of many things, he is constantly setting goals and thinking creatively, and he should always consciously evaluate the results of his efforts.

(Hanks, Belliston, Edwards 1978 (b): 93)

According to Hirano:

The learning creative-developmental process can be represented as a spiral. Viewed from the top, a spiral is a moving circle, constantly expanding in scope. Viewed from the side, upward movement is evident, representing the addition of experience and understanding.

(Margolin, Buchanan 1995 (a): 224)

This repetitive upward circular movement, corresponding to the feedback loops, gives potential energy in the constant re-evaluation of the old with the new.

The beginning of the design process is an analytical phase, whereby the designer seeks to find the structure, the centre and the essence of the problem. Without a well-defined ‘problem’, there is no direction to look for solutions. Stating the problem is where the solution starts, because the solution is hiding within the parameters of the problem statement. It has even been argued that the objectives, however abstract their form, are full of hidden assumptions about how the person stating it thinks it can be satisfied (Jones 1992 (a): xxix) It follows that the creativity and personality of the designer are present within the problem statement, just as the directions and concepts are also present from the very start where the problem starts to become defined.

As Bryan Lawson has noted, some problem statements are well defined, whereas others are ill defined; in the latter, further distinctions can be drawn, resulting in the subclass wicked problems (Rowe 1987 (b): 40). The wicked problems are characteristic problems without a definitive formulation, or even without the possibility of being fully defined. Therefore, any solution that is proposed is not final. Moreover, Lawson argues that rarely is a
‘problem statement’ well defined, or more accurately, precisely defined or ill defined, it is rather, relatively defined, depending on the designer or team of designers, and is always open to modifications or improvements at a later date. However, once the problem has been defined, a solution or solutions become accessible in terms of that definition (Rowe 1987 (b): 48).

The importance of trying to define the problem that needs solving cannot be overstated. Still it must be kept in mind that the understanding and statement of a problem is not objective. Each person will understand a problem according to a complex variety of personal and professional factors. The industrial designer sees a problem one way according to his possibilities and ideas for solving the problem; this process is different from how the architect views the problem and ideas for solving it. This is one of the reasons why designers are increasingly working together in teams, in order to access a broader-faceted understanding. It will be evident later in this paper why this is important for the creative process.

As a direct result of the problem statement, the designer enters the creative phase. This is where inspiration for the concepts towards solutions occurs, showing the capacities, personality, style and creativity of the designer; in short- the talent of the designer. The designer employs, whether consciously or unconsciously, a variety of impulses and tricks for creative innovation, including becoming intensely involved in the process. This intense involvement is an essential part of the process and is familiar to all creative people, who totally submerge themselves, using all the senses:

In order to feel the design one must immerse oneself in the subject. If you are interested in designing bar codes, try laying your head on a supermarket barcode scanner to really feel what it's like to be a barcode. Then go home and reinvent yourself. .

(Landa 1998 (a): 149)

The design process also involves the mental skills of the various thought processes and conceptual drawing. There are two main modes of productive thinking: thinking in "closed" systems, and ‘adventurous thinking’. A closed system, according to Bartlett, has a limited number of units, which may be arranged in a variety of orders or relations, as for example in formal logic, arithmetic, algebra and geometry. Closed system thinking can be highly creative, as in the case of discovering new mathematical proofs or making anagrams. ‘Adventurous thinking’ often depends for its success upon elements not normally related being brought together in a new way, hence its adventurous nature. (Rowe 1987 (c): 105)

Adventurous thinking corresponds to when we go forward in our attempts to create, closed thinking to when we ‘back-loop’ to adjust to previously established boundaries. These two modes of thinking relate directly to left and right brain modes, or, in other words, the rational, logical processes and the intuitive, imaginative processes.

The alternate use of both modes constitutes the design process. Both modes of thought are needed in creative invention. Even in the sciences, invention cannot be explained without reference to right mode thinking as well as left mode thinking, even though it might be thought that it is the latter which corresponds more closely to the so-called ‘scientific method’.

New paradigms suddenly and dramatically appear to overthrow the old, but using the established truths as stepping-stones. This corresponds to the way in which the design process unfolds; constant forward leaps and back-loop verification.

(Lawson 1980 (a): 116, 117)

A widely accepted model of the creative process, first proposed by Kneller and discussed by Lawson, can be used to illustrate how the alternation of closed thinking/open thinking or left brain /right brain thinking, is applied.
It proceeds in five stages:

- First Insight
- Preparation
- Incubation
- Illumination
- Verification

(Lawson 1997 (a): 152)

Each stage involves both thinking modes, and there is constant back-looping to a previous stage, helping the designer to revisit his problem formulation as the ground is being prepared towards a solution. The moment of illumination or ‘eureka’ seems to manifest out of nowhere, but it is known that, due to the previous incubation period, data have been combining on their own, so to speak. Why then does a solution always seem logical in hindsight? Because the brain can only accept logic; illogical ideas would be rejected.

The above model might imply that the process is linear, but on the contrary, as we have seen earlier; there is a constant back and forth movement among the various steps. Many designers talk about developing the ability to entertain several ‘tracks’ of thought simultaneously. This also refers to the many opposite considerations involved in the creative design process, such as thinking in the functional track, thinking in the inventive track, thinking in the material track, mechanical track, philosophical track, environmental track, the economic track, which again shows just how multi-facetted designing is. The moment of illumination in creativity might occur when the mind is able to by-pass the controlling character of the left-brain’s logic and make new connections between these old established tracks.

De Bono discusses this aspect of creativity, calling it lateral thinking. He argues that the brain works in patterns, without which we could not survive. These patterns can be viewed as grooves or tracks that have been formed by similar, repetitive experiences. These patterns are necessary to ensure speedy and competent reaction to outside stimuli without having to process each stimulus anew. Thus, whenever we look at the world, we relate to it in terms of these existing patterns, which can be compared to ‘highways’ in that they are the fastest and most effective ways for understanding and formatting information (Bono 1995 (a): 11). Normally, our thinking is limited to these highways, indeed it is more comfortable, and ‘safe’, and might feel more ‘natural’ not to challenge them; that is their function.

It takes a special, conscious effort to bypass the norm of the thinking process, since the mind’s purpose is not for creative thinking; it is made for survival. The analysis of information, reasoning with the left-brain, cannot yield new ideas; the brain can only see what it is conditioned to see. In order to get to the smaller roads, and make new connections that can lead to creativity, we need to trick the mind; to oblige the highways to connect with smaller paths.

(Bono 1995 (b): 147) This, de Bono calls ‘lateral thinking’, an act, which can also be attributed to humor as well; when the punch line joins together already familiar elements in an unexpected, or surprising manner.

Koestler also finds similarities between humor and wit, the art of discovery through analogous thinking and the discovery of art through metaphor, suggesting that in each one, new insights occur through “an act of collision”. (Papanek 1991 (a): 153)

Important to lateral thinking is the element of surprise, as the mind first goes along the main track, then there is a momentary pause due to stimuli that results in surprise, and then back to the main track, possibly from another
direction. This is similar to the point or moment of illumination of creativity. The tricks needed to stimulate this moment are provocations, which are methods of encouraging and facilitating escape from the main track in order to increase chances of getting to the sidetrack. Now de Bono makes an important point; that when we reach the step of verification; the left-brain thinking mode, we are only able to discover a good idea if and when it satisfies our known logic. We are not capable of bypassing this verification, possibly this is why inventions happen in small steps.

Using the same model we can also see why every valuable creative idea must always be logical in hindsight.

We saw earlier how designers more and more engage in teamwork: several designers from various backgrounds will brainstorm together. In view of the discussion on lateral thinking, highways and sidetracks, it is clear that only by introducing an element of surprise in the process is the designer able to create something new. Without some sort of stimuli, the brain will keep combining the information in an already safe and known manner. It cannot do otherwise- it is not meant to.

Just as the juxtaposition of unrelated elements can act as a stimulator towards creativity, so can a silent contemplation between one and oneself assist creative thinking. Alvar Aalto describes how he works after having collected the data:

In such cases I work – sometimes totally on instinct – in the following manner. For a moment I forget all the maze of problems. After I have developed a feel for the program and its innumerable demands have been engraved in my subconscious, I begin to draw in a manner rather like that of abstract art. Led only by my instincts I draw, not architectural syntheses, but sometimes even childish composition, and via this route I eventually arrive at an abstract basis to the main concept, a kind of universal substance with whose help the numerous quarrelling sub-problems can be brought into harmony.

Thus, thoughts vanish quickly, they have no substance; drawing and sketching is a way to commit into existence ‘in the space between the real and the imaginary’ (Ching 1990 a:200) the thoughts before they are concrete enough to be verbalized and communicated. In addition, ideas that are made visible in drawing can further stimulate the imagination. (Ching 1990 (b): 5)

Drawing, in other words, is a necessary part of creativity and the design process, and is a kind of dialogue between vision and thought. This is a view shared by many designers, including Michael Wilford, Clive Ashwin and Francis Ching (Lawson 1994 (a):108; Margolin 1989 (a): 199; Ching 1990 (c) 200). Of course, it must be understood that drawing for design purpose is not dependent on ability in artistic drawing.

In an unusual book, 6 chapters in Design, one of the designers, Milton Glaser, reminds us about the role that sketching also served:

The sketch … reveals the thought process of the creator in a way that a finished work is unable to do. When there are no sketches available to document creative activity, as is the case with Jan Vermeer or Piero della Francesca, for instance, we suffer a great loss…. What becomes obvious is that the process often reveals more than the work itself.

(Bass & Chermayeff & Glaser & Rand & Tanaka & Tomaszewski 1997 (a): 128)

In addition to letting us understand the steps through which the creative process passes, sketching is also a record for posterity of something very intimate and personal; the thinking process.
One reason why most designers cannot talk about design without a drawing tool at hand is because it aids the verbal with visual communication:

The mind’s eye is capable of an inner vision which is not limited to the here and now. It can form, manipulate, and transform images beyond the normal bounds of time and space. These images, however, are often vague and elusive, and can easily be lost to awareness. In drawing what we envision, we take advantage of our ability to think in visual terms and give form to our thoughts and ideas. These drawn images feed back to the mind’s eye, further stimulate our imagination, and provide a dialogue between self and image for further exploration and development of ideas. Drawing from imagination thus is an instrument of thought, which enhances the creative process.

(Ching 1990 (d): 137)

Up to now we have established that the design process begins with an attempt to define a problem statement; an intense rush of creativity then follows, comprised of both thinking modes, and kindled by various impulses and stimuli. This is an unstable phase where thoughts are not yet concretized, and therefore the use of drawing is a necessary component in the process.

The significance of this first occurred to me while doing research for my masters on the design process; my intention was to investigate the design process in order to improve teaching methodology. Part of the research involved interviewing designers and students of design, who, when asked about their particular design process, were unable to fully express themselves verbally, and would invariably and unconsciously depend on hand and body gestures as well as a drawing tool. Since verbal expression did not seem adequate, I decided that a productive way to discover more about the process would be to ask designers to draw what they thought was their design process. Of interest for this paper are the interviews with five design instructors and five students. Questions were given to the instructors at least one week prior to the interview, of which two are significant for our purposes today. These are:

1. **How do you define ‘design’?**
   Please consider a broad meaning of the word.

2. **How would you define ‘design process’?**
   Please describe your personal method when designing?
   Is there a specific sequence of steps you go through when designing?
   As a visual person can you give a graphical representation of how you see the design process?

The answers resulted in some fascinating diagrams that are truly individual and personal. All the five instructors are both professional designers as well as educators. The first is an assistant instructor, newly graduated in graphic design. He defines the design process as:

1. ... a problem-solving methodology. It is an answer to a need. I believe everyone designs, when you decide what to wear, how to decorate your house. A psychological profile, a management structure, is also designed.

2. First understand exactly what is the problem, by trying to define what is the problem, then research in many directions. You don’t always know in which direction you are going. Then sketching, brain storming, you with yourself, get all ideas down – they might lead you somewhere. Then you decide the direction. At one point I thought I could jump directly into the final product. With the computer, I thought it could do the design for me. Now I know it is only a tool. So I am back to sketching manually. Several students have this problem.

Looking at the diagram (see diagram no. 1) there are outside, firm, boundaries, implying that the focus is not lost at any time. Simultaneously several small investigations are made.
The second instructor is a professor with a PhD in graphic communication, management and technology. He sees the design process as:

1. Aesthetics, in general. Make the world more beautiful, better. This concerns marketing, foods, goods, and services. There is a change, to seek more information of the consumers’ needs and wants. Without this information, design cannot happen, it is a collaborative effort. It is a sequential, simultaneous process.

2. The generation of ideas! How? Through creative VISIONS. Then develop vision and transmit into product. Individual source. To collect ideas; library, read, learning process. It is lifetime learning; conferences, new courses, you become organized through the learning, organized in the thinking, the brain. Through the recollection of these inputs then you can create a new entity.

This diagram (Diagram no. 2) is very powerful, dramatic even. Lots of activity in the beginning, several directions are taken, daring and open. A strong analysis and decision statement. Followed by further development of the idea, until production. The final output can then be reevaluated and slight changes can be made.

The third instructor is professor with a PhD in Art Administration/Art education. He suggests that design is:

1. Problem solving, confronted with a problem, try to provide valid solutions. Approach various angles depending on the problem, and remember that there are many valid answers. The process is to answer to a problem in the most creative manner.

Design is part of everything we do. The problem is that people believe it is only with aesthetics. It is a way to thinking we cannot limit it to colors, lines, etc. It is a way of responding to our environment.

2. I try to analyze the design problem, what is more important, establish the priorities. What is the relationship between the more important to the lesser important? Designing is not done in a linear manner. Design goes in circles, just when you realize it is going well, and then you have to go back and verify. It is a multidirectional process. I cannot pursue one direction only…I try to think across on all these issues at the same time, which the mind cannot. So I address the most important first and try to include all the other issues, and go back all the time. So design is relative, not perfect…Design is a much more of a global issue than we think. I must start with an idea. I cannot start to work without an idea. And then I must work very hard to engage. Concepts are very important if I start without a concept I am presenting just a mere solution. …You must be able to criticize your own and other projects, in an open-minded manner. There are no absolutes….Design is an ever-changing discipline’.

His diagram (Diagram no.3) is very analytical, ordered, and sequential, it is a learned process rather than a felt process. He is not really a designer himself., Rather an administrator and theoretician. The graphical design of the design process is an expression of this. It is rather schematic from a book.

The fourth instructor is chair of a graphic design department at a university and has a MFA in design. He defines design and design process this way:
1. Everything is design. It is a problem solver. I ask my students to call themselves designers, not to say graphic designers. Because design is everything.

2. "My methods is a balance of intuition and process; follow this idea, go back, and analyze it, and again, same thing. Basically my tuition is based on all my knowledge. I start sketching or I work directly on the MAC. I give a project 2-3 days thinking time before I start, call it incubation time. Sometimes I go back through the steps. My process has not changed. Except that now I know that I do not need to panic, I know I will get through. After ending a project I wait one month then I write myself a critique, and use it to improve, because there is always ‘better’

The diagram (Diagram no. 4) is personal. One crooked line, not regular, not predictable, not controlled. Going in all directions, following its own intuition, not limited by anything. This diagram is of a felt and lived design process.

The fifth instructor is lecturer in a graphic design department at a university. He has a master of design degree.

1. Design is a powerful tool/weapon that can be used to twist the thinking, turn black into white. Yet it can also be used positively to make life more enjoyable, be it a poster, an interior. So we designers have a tool to either enhance or damage the environment in a broad sense. Designers can easily be corrupted.

2. There are theoretical steps in the design process that we teach in an academic setting; brief, analyses, synthesis, etc. Once actually designing the process becomes more loose, more subjective, more inter-looping. There is a beginning and there is an end. At one point in the process the beginning is not longer the beginning.

His diagram (Diagram no.5) is unusual in that he perceives it as a volume, one ball of threads that go in and out, there is no direction, there is no point that says here is the decision taken, it is a process without end. It is a diagram made rather by the intellect than the how the process is felt to be.

There are also five diagrams drawn by first year students of interior and graphic design. What was surprising to me was the gusto and confidence with which they would attack the challenge of drawing their design process, as they had barely been introduced formally to any process at all, apart from projects in 2D and 3D design. All students except one understood that several paths of investigation are followed, also back looping is present.

The first student’s diagram (diagram no.6) is clear, angular, and analytical; the process is nearly designed in equal sizes. It is full and looks well thought through.
Student no. 2 (diagram no.7) looks very interesting, more like a computer chip than a design process. But as a translation of the design process, it is more than adequate. There is a general direction, but not centered, no attempt has been made to exercise control. Several sidetracks are entertained and the diagram kind of freely spreads out in all the space available, which would result in a very rich design process. Unique to this diagram there is a thick black wall, like a path taken and rejected at some point, possibly after plenty of faith in that direction.

Student no 3 (diagram no.8) is barely a diagram, as it consists of one line only. A beginning and an end. Which is also what design is about. Maybe it cannot yield the most inspired solutions, but it would get the job done. The only limitation is that either the designer has to wait for one inspiration to solve the problem, or jump to a pre-conceived already known idea. There's no investigation or input to facilitate the process.

The fourth student's diagram (diagram no.9) starts out with a box of information, and then several solutions or directions are entertained. Some are more suitable than others. But no convincing solution is reached. Then a major “chance” sidetrack is looked upon; maybe this idea can bring something new? Yes, something interesting is appearing. It is brought back to order, one direction is decided upon and after a few trials a final solution is reached.

The final student's diagram (diagram no. 10) is straightforward. One box of input, some expanding on ideas, not too much, trying not to get too far away, no time wasted here, then some decision is reached, several minor roads are looked upon in a soft manner, rather like testing the ground based on already known facts, rather than daring major leaps into the unknown, then in a straight line the process continues until the end.

An interesting aspect of these diagrams is that everybody involved in design cares about their individual design process. There is a definite ownership.

Each of the 10 diagrams is personal, even though, interestingly, they still correspond to and go through the stages of the classical, well-known paradigm of the design process, as proposed by Dennis Thornley (1963) and adopted by the Royal college of Art in London and the Royal Institute of British Architects. If they are compared to some of the classical diagrams of the design process that Rowe suggests, it is clear that they are individual yet could be seen as variations on a theme.

A fascinating line of inquiry would be to examine whether the energy bursts and signs of assertiveness that can be read in the diagrams are related to personality. The research also raises some interesting questions about the use of computer in design and whether it limits free association. There might be a real need to commit to paper part of the many thoughts happening in the mind, since it is impossible to try and recapture all the steps and ideas if all this activity occurs in virtual reality. There would be no tangible expression of the activity that has taken place and therefore it would no longer be possible to revisit and compare: to back loop or to sidetrack.

It was also necessary to include a discussion about thinking modes, left and right, to help clarify the reasons why it may be so difficult to talk about and express one's design process, and why drawing is so necessary. People who are creative, meaning that the right brain is active or dominant, have inner communication with the right brain,
not necessarily through words. The left brain, which controls for logic and verbal communication, will invariably verify and validate what is being said. The abstract ideas that the right brain attempts to express are not convergent with the linear straightforward logic of the left brain. Hence a conflict arises that inhibits easy verbal expression. By drawing the design process, the right brain is free to communicate all it can, thereby bypassing the controlling nature of the left-brain. (Edwards 1989 (a): 36)

The diagrams are, in other words, an unfettered, creative expression of the design process without the censorship of the left-brain.
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