Design Methods: seeds of human futures

By John Chris Jones 1970, John Wiley and Sons, New York and Chichester

An introductory lecture for digital designers by Rhodes Hileman (c) 1998

"Jones first became involved with design methods while working as an industrial designer for a manufacturer of large electrical products in Britain in the 1950s. He was frustrated with the superficiality of industrial design at the time and had become involved with ergonomics. ... When the results of his ergonomic studies of user behavior were not utilized by the firm's designers, Jones set about studying the design process being used by the engineers. To his surprise, and to theirs, Jones' analysis showed that the engineers had no way of incorporating rationally arrived at data early on in the design process when it was most needed. Jones then set to work redesigning the engineer's design process itself so that intuition and rationality could co-exist, rather than one excluding the other." ...and this became a consistent thread throughout his work.

Overview:

Take a look at the Table of Contents (pages v-vii). The book is divided into two parts.

Part one gives a brief history of design, argues that new methods are needed for today's more complex realities, breaks down the design process into three stages, and shows us how to choose a design method for each stage.

Part two consists of descriptive outlines, or recipes, for 35 design methods. These methods include:

- *logical procedures*
- *data gathering procedures*
- *innovative procedures*
- *taxonomic procedures and*
- *evaluative procedures*

Reading part one gives you a grasp of the book. After that, the methods in part two are best read singly or a few at a time.

Context:

Now, flip past the prefaces and figures to the picture of a wagon.

The context of the book can be given as a brief history of design. Jones relates this heritage in four eras.

The era of "Craft Evolution"

This wagon (figure 2.1) is a fine example of craft evolution, the first of the four eras identified.

Before the Renaissance, the craftsman carried in his head a set of rules about the design of the tools of the day, which roughly described a useful artefact with "invisible lines", which limited the dimensions and shapes of the parts in relation to the whole tool. Designs were slowly evolving in a living collective knowledge base, and few craftsmen made any major changes. Design was limited very closely to the neighborhood of the tried and true.

As an example of the sketchy understanding of design which craftsmen had, Jones cites George Sturt, author of The Wheelwright's Shop, wondering why the wheel on a wagon was "dished". If you look closely at this picture, you will see that the hub of the wheel is recessed from the plane of the rim, so that all spokes reach slightly outward from hub to rim. Sturt the craftsman knows it has to be this way, but can not explain why. Many years later, as author, he hits on it: the gait of the horse imposes a side to side rhythmic swaying to the wagon; the wheel must be slightly dished to resist this force. He says, "The nature of this knowledge should be noted. It was set out in no book."

The era of "Design by Drawing"

See Figure 2.2. an example of the second era.

From the renaissance to the 1950s, design was generally done by individuals. A patron submittted a "brief" to a designer who produced a solution to the given problem by a method which is now dubbed the "black box" method. As the name suggests, the process of design itself was not visible to anyone but the designer, and sometimes he didn't really know how he discovered the solution himself. Nor could he always give you the rationale behind every choice made in the design. However, he could design something that was too big for a single craftsman to construct, like a ship or a cathedral, and in both these cases, he must have had some technical understanding of the

forces involved. This was a step past craft evolution.

The era of "System Designing"

The first steps to bringing the process of designing out of the black box and into the realm of conscious group effort occurred in the twentieth century, more or less as a result of the tremendous collective efforts required by World War Two. The first reports of systematic design in groups appear, in civilian life, in the 1950s. Methods which Jones identifies in this stage are brainstorming, synectics, removing mental blocks, and Analysis of Interconnected Decision Areas (AIDA). At this stage, design by drawing becomes a tool for solving a sub-problem, an element of a system which is too large for one person to complete. Examples of such systems are: a 747, a modern hospital, or a computer operating system. Do you see how this is progressing? Things are getting complicated.

The era of "Technological Change (or Socio-technical Innovation)"

The next, and present, era is characterized by its concern with a larger realm of factors, both in the market, and in the social, economic and ecological environment. We hear of "test-marketing a concept", and the use of "focus-groups", which inform the earliest stages of the design. More sophisticated approaches to the psychology of designing begin to find actual use by design teams.

See Figure 2.1.1 "Strategy Switching" for an example of a modern method of problem exploration and design evaluation which permits "spontaneous thinking to influence planned thinking, and vice-versa." This is one of many methods which allow multiple levels of intelligence to work together, sometimes called "co-intelligence".

Let's take some time to examine this method. The designers keep a log of thoughts that occur spontaneously which appear irrelevant to the design in process. Each thought is recorded in detail. When this material becomes substantial, it is periodically reviewed in parallel with the design in progress. If the patterns of the spontaneous thoughts contradict the design, decide either to ignore the thoughts or construct a new design strategy that more closely fits the pattern of thoughts. Repeat until the thoughts converge on the selected design.

Stimulated by the emergence of such methods in England and North America, a "Design Methods Group" was founded in 1966 in Canada by Gary Moore, then an architecture student at UC Berkeley, and Marvin Manheim at MIT. Throughout the late sixties and early seventies this group held annual conferences and published papers on design research.

Architects, confronted with design efforts involving many designers and many stakeholders, were forced to study their methods to make them more open to scrutiny and input at all stages. Many of the design methods in use today have grown from their work.

Product designers also had to respond to a wider array of factors. Driven by issues of environmental impact and social equity, as well as function and fashion, product markets were demanding changes.

We had begun to raise our perspective to include a much larger picture, ranging from the designer's internal processes all the way to planetary conditions. We were re-designing design, and by 1991 Jones wrote another book called "Designing Designing".

The present work, Design Methods, was a seminal book appearing early in this ferment in 1970. It is widely credited with stimulating fresh approaches to design and is still today a very useful work.

What is designing today?

I want you to take a moment to create a definition of design. On the back of your bundle, write your definition of designing. I know of no right answer, but after we share our definitions, we will look at the attempts of 11 professionals.

Take one minute. Then we'll read them.

Here's what the pros said (in the 1960s):

Finding the right physical components of a physical structure

A goal-directed problem-solving activity

Decision-making, in the face of uncertainty, with high penalties for error

Simulating what we want to make (or do) before we make (or do) it as many times as may be necessary to feel confident in the final result

The conditioning factor for those parts of the product which come into contact with people

Engineering design is the use of scientific principles, technical information and imagination in the definition of a mechanical structure, machine or system to perform prespecified functions with the maximum of economy and efficiency

Relating product with situation to give satisfaction

The performing of a very complicated act of faith

The optimum solution to the sum of the true needs of a particular set of circumstances

The imaginative jump from present facts to future possibilities

A creative activity - it involves bringing into being something new and useful that has not existed previously

Jones points out the variety present in this set.

Questions for the designer

One of the first questions which must be answered in the process of researching every aspect of a design problem is this:

Does the penalty for not knowing exceed the cost of finding out?

If the answer is negative, that part of the problem should be ignored, at least until the answer becomes positive.

Here are typical questions about a product design under consideration:

Will the sponsor like it?

Is it in his interest to invest in it?

Will it be put into effect?

Does it make the best use of available materials and components?

Can it be made cheaply enough with available resources?

Can it be distributed through available channels?

What appearance, performance, reliability, etc. is required?

To what extent will it be compatible with, or competitive with, other products?

To what extent will it restructure the existing situation to create new demands, opportunities and problems?

To what extent are its effects, and side-effects, acceptable to all concerned?

Challenges for the design manager

While the design engineer confronts these questions, the engineering manager must also keep his/her eye on a higher set of concerns:

1. Identification and Review of Critical Decisions

2. Relating the Costs of Research and Design to the Penalties for Taking Wrong Decisions

3. Matching Design Activities to the Persons who are Expected to Carry Them Out

4. Identifying Usable Sources of Information

5. Exploring the Interdependency of Product and Environment

Managers of a design process must ask these questions repeatedly to keep a design group on track and within budget. These criteria reflect the meta level of design. Attending to them has been best practice since the fifties at least, and is another characteristic of the present design era.

Deconstructing designing.

Design breaks down into three stages:

1 Divergence

2 Transformation

3 Convergence

Understanding these stages of design is a very powerful tool for design management, and one which engineering managers ignore at their peril.

If you get nothing else out of this talk, but you get this, you will still come out ahead.

Divergence

This stage is "...the act of extending the boundary of a design situation so as to have a large enough, and fruitful enough, search space in which to seek a solution."

The objectives, and the problem boundary, are unstable and tentative.

Evaluation is deferred, as in "brainstorming".

Every effort is made to escape old assumptions, and absorb new data. Several methods in this book are aimed squarely at this challenge.

The territory of the problem is tested to discover limits, consequences, and paradoxes. Fact-finding is important now, to find the shape and the context of the problem. This is the time for research. We ask:

What is valuable?

What is feasible?

What is dangerous?

Where are the dependencies between elements?

What are the penalties for getting it wrong?

Are the right questions being asked?

Transformation

Now we shift gears. The research phase is mostly done. We have mapped the territory of the problem. The focus of design narrows to a more practical level. Operative words here are

eliminate, combine, simplify, transform, or modify. *This is the stage when objectives, brief, and problem boundaries are fixed, when critical variables are identified, when constraints are recognized, when opportunites are taken and when judgements are made.*

This stage is "...pattern-making, fun, flashes of insight, changes of set".

The main objective is to impose, upon the results of a divergent search, a pattern that is precise enough to permit convergence to the single design that must eventually be decided upon and fixed in every detail. The chosen pattern must reflect all the realities of the situation. Pattern-making ... is the creative act of turning a complicated problem into a simple one by ... deciding what to emphasize and what to overlook.

Now the problem gets structured into subproblems which can each be solved in relative isolation, and in parallel by different people.

The freedom to change sub-goals, to add or remove features, is important, and the ability to quickly predict their feasibility and consequences is critical.

This stage "can *occur* unexpectedly at any time, but ... should only be *applied* after sufficient divergence has occurred..."

If a design evaluation committee is confronted with rival transformations, the solutions should not be mixed. Instead, one of them should be selected.

Convergence

At this stage *the problem has been defined, the variables have been identified and the objectives have been agreed. The designer's aim ...[is to] reduce the secondary uncertainties progressively until only one of many possible alternative designs is left...*

Persistence and rigidity of mind is a virtue: flexibilty and vagueness are to be shunned.

Models become more concrete and detailed.

If "unforeseen subproblems prove to be critical" then the design process must shift back to transformation mode where all variables can be considered.

Convergence can be done, as a programmer would say, from the top down or from the bottom up; or architecturally speaking, from the outside inward or inside outward. The best approach is often to do both at once, and resolve differences as the two processes meet.

This is the only aspect of designing that appears to lend itself to a wholly rational explanation... and as such can probably be done by a computer. The irony is that this is the stage that traditionally was considered the whole of design; yet it is likely to become that part which people do not do at all.

Choosing design methods

Turn to the back of the bundle. See figure 6.9 on page 82, comparing it with figure 6.8, p 80.

Figure 6.8 is a map of the book. It is a matrix of dependencies that shows all 35 design methods in part two of the book, some of them in more than one place. Inputs are on the left; outputs are across the top. Above the diagonal line are "normal" forward progressions of design phases 1,2,3,4,5,6; while below the line are regressions, or feedback loops to earlier phases, 3 to 2, and 4 to 3. So a normal progression through this matrix might start with methods from row 1 column 2, say, Method 3.1 "Stating Objectives" and 4.1 "Brainstorming", and then use something from row 2 col 3, then row 3 col 4, and so forth. Each method is expected to produce output which is a suitable starting place for the next phase of design.

Figure 6.9, p82, shows what should be an overlay to this matrix of methods. It illustrates that the historical progression - the four "eras" described previously - of our concept of design, has moved backwards from the final phases to the earliest phases. Take a moment to study this. You can see that "Craft Evolution" encompasses only cells 5-6 and 6-6, while "Technological Change" constitutes the entire matrix.

"Choosing Design Methods" on pages 79-82 shows how these methods fit into the three stages of design - divergence, transformation, and convergence.

Page 85 shows an example of choosing methods for a design problem: choosing a site for a new airport. To understand how those particular methods would suit the problem you will have to read the descriptions in part two. For that you'll have to buy the book.

The 1992 edition has added several prefaces which are well worth reading. The 1992 preface is included whole in your bundle, and the opening page of the 1980 preface. These help explain how to use the book.

Conclusion.

Design today is an increasingly social art, involving multiple designers, and multiple stakeholders as client/sponsor, suppliers, manufacturers, distributors, consumer/customer, and citizen groups and government agencies concerned with a shared environment, all get into the act. Individual design geniuses now must learn to communicate and negotiate effectively to

succeed in the current enterprise environment. The old “Prima donna” behavior is rarely tolerated today.

Advances in the capabilites of engineers and engineering tools must be matched with advances in techniques for resolving a broader range of issues and demands, and more effective communication skills and design transformation skills among designers and design managers.

Computers will drive the role of humans in design to the earlier stages - divergence and transformation - of the design process where flexibility, intuition, and soft-focus attention are required. Knowledge-base systems will take over the convergence stage, kicking the problem back to us only when discovered contradictions force re-evalution of design goals. The iteration of complete designs from a given design problem definition will become faster as our knowledge base improves and as computer power increases. As this speed increases, a threshold will be reached where *qualitative* changes in both design and designing will result.

Notes:

Where whole paragraphs are Italicized in the above text, a quotation from the book is indicated.

“Deconstructing designing” is derived from chapter five of the book.

“Choosing design methods” is derived from chapter six.

For more on “Co-intelligence” see www.cointelligence.org , This word was coined by Tom Atlee who founded the Co-intelligence Institute.

For those familiar Future Search, this large group intervention can be seen in terms of the three stages of design. The past and present inventory exercises which produce the timeline and mindmap are the divergence phase. The future scenarios exercise is the transformation phase, and the action groups is the convergence phase. Probably many other such “real-time” group transformation processes could be similarly analysed.

Other books on design process in digital products:

The Psychology of Computer Programming, Gerald M. Weinberg, Van Nostrand Reinhold, 1971

Rethinking Systems Analysis and Design, Gerald M. Weinberg, Little, Brown and Co. 1982

Techniques of Program Structure and Design, Edward Yourdon, Prentice Hall, 1975

The Mythical Man-Month, Brooks,

On architecture:

The Timeless Way of Building, Christopher Alexander, Oxford University Press, 1979