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GENERIC DESIGN
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Preface

This study had been started in 1975 - in a time the Generic Design concept and idiom had not been coined yet - with the beginning of my Ph.D. Degree research in the field of Industrial Design Theory and its Applications. In those days there were no any comprehensive scientific efforts had been carried out to handle the important similarities between different design tasks in different domains. In fact the only comprehensive scientific efforts in the field of Industrial Design Theory had been carried out by Christopher Jones in his book Design Methods: seeds of the human, Pergamon, London, 1962. Jones handled the available Design Methods in these days and try to classify them according to his suggested Design Program.

My Ph.D. Theses under the title "**Modern Trends in Industrial Design Techniques and it's Applications in Egypt"(1977),** consisted of the results of a comprehensive search of the Design Program from the historical point of view in one hand, and a serious trial to achieve group of procedures had been ordered in a logical way to be useful as General Design Program (GDP) on the other hand. The results came in a form of eight stages in there logical order in one hand, and the detailed clarification of the objectives & achievements of each stage.

Introduction

GENERIC DESIGN "HYPOTHESIS"

■ **Underlying conjecture**

• important similarities between different design tasks in different domains (e.g. Architecture Design, Engineering Design, Industrial Design, Software Design, but also Traffic Signal setting and planning of routes or meals.

and

• important difference between design tasks and non-design tasks.

but

• there are different "forms" of Design

DESIGN PROGRAM

• all design projects have to be carried from practical point of view in a limited time, within certain finance and with the help of the available resources.

• all business tasks, even simple ones, need a certain degree of programming.

• essential features of any program could be summarized in evaluating the content of the required task, with the estimation of time and costs needed to complete each of its stages.

• design as a task needs to be organized in a certain way, utilizing a logical design procedure can help greatly in this respect owing to that procedure can give special attention to each sub-task of designing.

• design procedure greatly affected by the nature of the problem and different methods & Techniques selected to achieve the proper solution.

• following a Design Program is considered as one of the most important tools which can help designers to perform their tasks in a proper way. In fact we can consider it the main tool in that respect or the backbone of the design activity because it can clarify the systematic way and put group of milestones could be followed to arrive the final design.

GENERAL DESIGN PROGRAMME

In an attempt to achieve group of ordered procedures in proper way to be useful as a general design program a precise analytical study is needed to be made for the existing design program in different domains of design beside logical steps used to solve a problem whatever it is, to achieve important similarities among them and can form the main stages of a design program.

This study has to cover three main areas:

• A historical look at the proposed logical stages of problem solving, (first generation)

• A survey of problem solving procedures in the field of design as a theoretical issue from the beginning of the sixties of the 20^{th} century (the start of the space age) till the amazing appearance of the computer age (second generation).

• The contemporary efforts for the formulation of Generic Design (third generation).

THE HISTORY

■ In the beginning “Dewey” suggested, according to the examination of the human thinking way, five steps can explain the way of thinking when a problem is in need to be solved.

■ Dewey’s Suggestion had influenced so many theorists who were interests in that field to point out their opinions concerning those steps and/or problem solving stages in genera:

§ Dewey (1910)

1. A felt difficulty.
2. Its location and definition.
3. Suggesting possible solutions.
4. Development by reasoning of the bearings of suggestion
5. Further observation and experiment leading to its acceptance or rejection..

§ ***Burt* (1928)**

1. Occurrence of perplexity.
2. Clarification of the perplexity.
3. Appearance of suggested solution.
4. Deducting implications of suggested solution.
5. Verifying action or observation.

§ ***Gray* (1935)**

1. Sensitivity to problem.
2. Knowledge of problem conditions.
3. Suggested solution or hypothesis.
4. Subjective evaluation.
5. Conclusion or generalization.

§ ***Johanson* (1944)**

1. Orienting to the problem.
2. Producing relevant material.
3. Judging (a critical function) the solution.

§ ***Polya* (1948)**

1. Understanding the problem.
2. Make a plan.
3. Carry out the plan.
4. Look back on the completed solution (plus a long list of mental operation).

§ ***Humphrey* (1948)**

Directed thinking involves

1. A problem situation.
2. Motivating factors.
3. Trial and error.
4. Use of association and images.
5. A flash of insight (covers c, d, and e and rests on the problem).
6. Some application in action.

§ ***Bloom* (1950)**

The four characteristics are

1. Understanding the nature of the problem.
2. Understanding the ideas contained in the problem.
3. General approach to the solution of the problem.
4. Attitude towards the solution of the problem.

§ ***Burack*** **(1950)**

Methods of attack

1. Clear formulation of the problem.
2. Preliminary survey of materials.
3. Analysis into major variables.
4. Location of crucial features.
5. Application of past experience.
6. Varied trial.
7. Control.
8. Elimination of sources of error.
9. Visualization.

§ ***Hoffman and Co-workers*** **(1951)**

Analysis of the Objectives of problem Solving

1. Sensing significant problem.
2. Defining problem situation.
3. Studying the situation for all facts and clues bearing upon the problem.
4. Manipulating the laboratory equipment needed in solving a problem with understanding of its function.
5. Making the best tentative explanation of hypotheses.
6. Testing hypotheses by experimental or other means.
7. Accepting tentatively or rejecting the hypotheses or testing other hypotheses.
8. Drawing conclusions. Using the hypotheses for generalizing in terms of similar problem sitiuations.

§ ***Vinacke*** **(1952)**

1. Recognition of the problem.
2. Manipulation or exploration of some kind.
3. Analysis.
4. Partial solving.
5. Emotional responses.

§ ***J. Stanley Gray*** **(1956)**

Methods of Problem Solving

1. Understand and habitual solving.
2. Blind trial and error behaviour.
3. Insight behaviour.
4. Vicarious behaviour.
5. Scientific method.

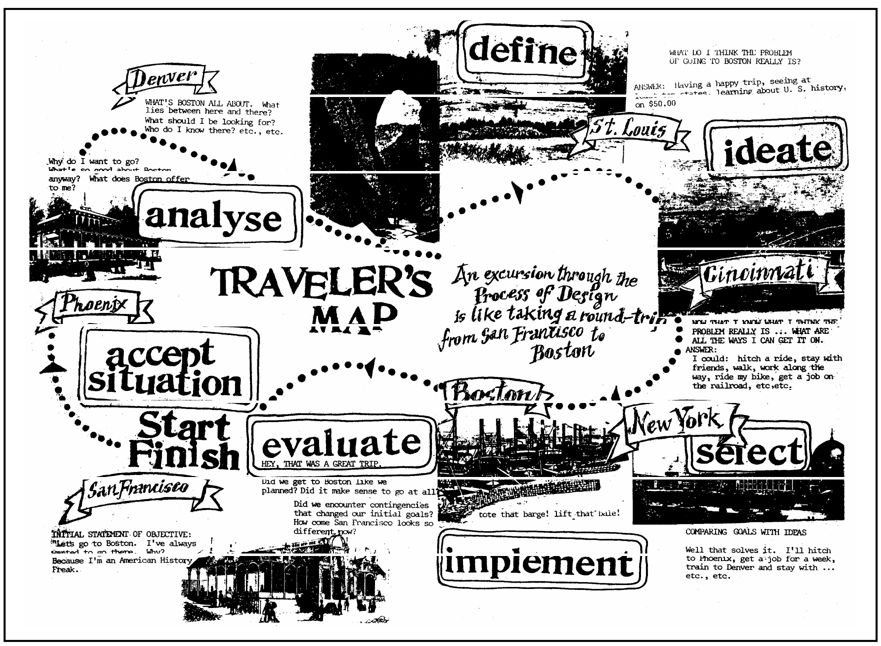
§ ***Mills and Dean* (1960)**

1. A difficulty is recognized.
2. The problem is clarified and defined.
3. A search for a clue is made.
4. Various suggestions are made, and are evaluated and tried out.

§ ***Jones* (1962)**

1. Brief issued
2. Design situation explored
3. Problem structure perceived or transformed
4. Boundaries located, sub-solutions described and conflicts Identified
5. Sub-solutions combined into alternative designs
6. Alternative designs evaluated and find design selected.

§ ***Koberg* (1973)**



1. Accept situation
2. Define
3. Ideate
4. Select
5. Implement
6. Evaluate

§ *Mapping a Domain Model to a Generic Design* (1994)

A mapping process for producing a generic design from domain models is described in [CMU/SEI-94-TR-08]. This mapping process starts with the assumption that there is already in place a set of Feature Oriented Domain Analysis (FODA) concrete models. This mapping process consists of four steps shown in the table below, whose intent is to identify:

1. the major physical and/or logical abstractions that maintain state, the domain objects, and
2. the group of related features that describe the subsystems which utilize the objects in their implementation.

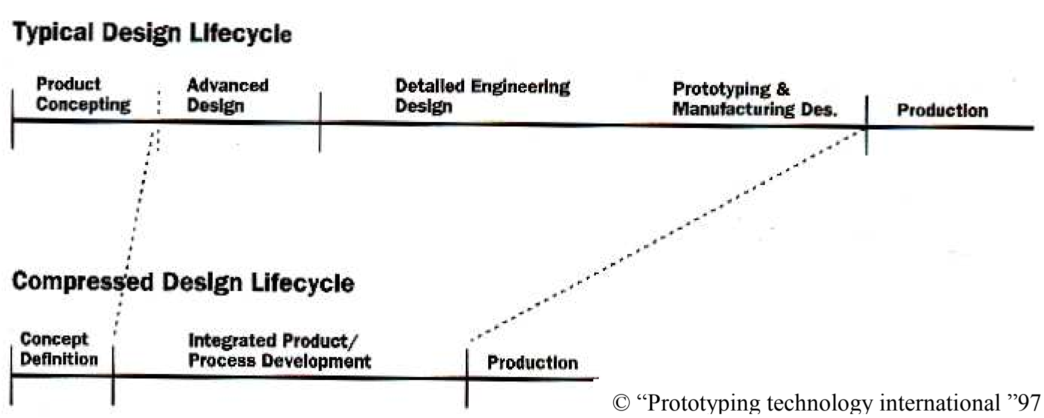
The products of this mapping process are specification forms for the three logical abstractions within the Object Connection Architecture (OCA): subsystems, surrogates, and objects. These specification forms provide pointers to information elements about data, capabilities, and behaviors from the Information, Features, and Operational Models, respectively. The ultimate goal of the specification forms is to provide the software developer with access to the information needed to implement functionality.

> For additional detail on any of the steps in the table, simply click on the row in question. It is important to note that the steps listed in the table above are given in the order in which they should be performed. The only notable exception is that the creation of subsystem and surrogate specifications, which may be performed in either order or concurrently.
>
> Before beginning the mapping process, it is important to know what the major goal of the process is, because various alternatives exist such as :
>
> > One may select a limited set of features that map readily to a core set of capabilities that are to be used in a product or as a domain demonstration
> >
> > One can include all features of major capabilities into the process, which may lead to the most robust and reusable design possible. The development of such a design and its components may be a very difficult task. This is due to the potential for a high degree of complexity when implementing and integrating the use of a potentially diverse set of features and underlying objects.
>
> These two extremes have different success criteria and cost versus benefit trade-offs.

Steps	Action	Product
1. Select Features from Domain	Identify desired features from features model, i.e., operations, context, and representation	List of desires features
2. Create Object Specifications 1. identify Objects 2. Derive Object Operations and Inputs/Outputs	Identify data items maintaining state or requiring explicit control. Analyze features model for operation variations based on alternatives or context and shown in operational model	Initialized Object From Entity List Completed Object form
3. Create Subsystem Specification	Group together objects that work together, correlated to set of related features in features model.	Complete Subsystem Form
4. Carat Surrogate Specifications for Device	Determine external interface for applications and determine their control and data characteristics	Initialized Surrogate form

§ ***Peter J. Effler & Jeffrey D. Saal*** **(1997)**

Effler and Saal from Andersen Association (UK)handled in there study under the title "Prototyping :a design chain integration perspective" a new vision for the integration of the design program stages - in the context of new Design Theory – into only three stages instead of the six stages of the typical design lifecycle as shown in the diagram:



© "Prototyping technology international "97

GENERIC DESIGN "PROPOSED"

According to the achievements of my Ph.D. research (1977) in one hand and with regard to the contemporary contributions to the logical procedure on the other hand, we can see clearly that the model of the general design program established in 1977 is still:

- Representative: enough to clarify the behavior of the different aspects of the presented phenomenon
- Robust: enough to give reasonable amount of the results representation, even if there are some missed or wrong data found
- Flexible: Enough to be malleable to match data and/or relations alterations

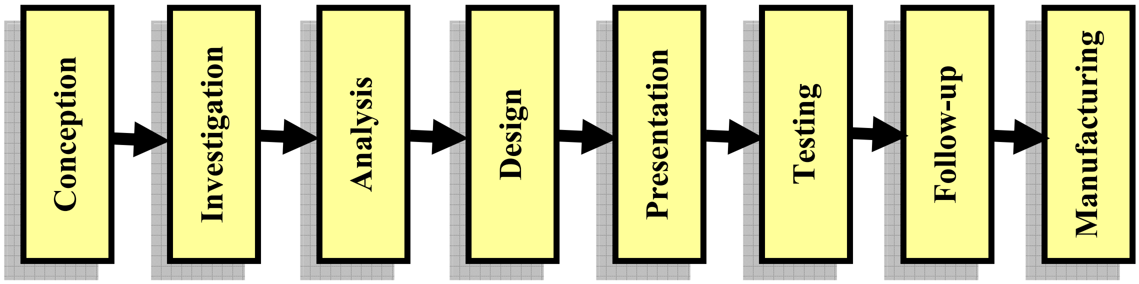
The model of the general design program which consist of the main tasks existed in almost all established design programs in different domains cam as follows:

First Stage **:** Formulation of a concept about the intended project objectives
Second Stage**:** Collecting available information on the problem and its possible solutions
Third Stage **:** analyzing and classifying the collecting information
Forth Stage **:** Generating, Evaluating and Selecting ideas suitable to solve the problem
Fifth Stage **:** Presenting the selected ideas
Sixes Stage **:** Testing the new features
Sevens Stage**:** Follow up developments
Eighth Stage**:** Manufacturing the new product

These eight stages could be considered the most ordered procedures of the design process from the logical pint of view. This general design programme can follow any Strategy according to the nature of the problem and its circumstances. Design Strategy can take one or more of the following patterns as quoted in Jones, 1962 and Koberg et al, 1973:

- ***Liner Strategy***
- ***Feedback Strategy***
- ***Cyclic Strategy***
- ***Branching Strategy***
- ***Adaptive Strategy***
- ***Incremented Strategy***
- ***Spiral strategy***

For the sake of simplification we will borrow the liner strategy pattern to clarify our Design Program features as follows:



The following table shows the objectives and the achievements of each stage of the General Design Program (generic Design):

Stages		Objectives	Achievements
1st	**Conception**	**Having basic and adequate ideas about the main objectives of the project.**	**Information about the problem and the intended objectives from the originator point of view.**
2nd	**Investigation**	**Collecting available information about the project under study and related aspects**	**Lot of information about the project requirements**
3rd	**Analysis**	**Information analysis and classification to establish the project parameters and specifications**	**Project specifications for the sake of generating new ideas and solutions**
4th	**Design**	**Generating, evaluating and developing candidate ideas & solutions**	**Accepted design proposal, virtual physical models, mock-ups and prototypes**
5th	**Presentation**	**Presenting the design features & aspects to home it may concern**	**More detailed specifications about the selected design idea in a form of design documentation**
6th	**Testing**	**Verifying the validity of developed solution and its value**	**Feedback information about the new design value**
7th	**Follow up**	**Carrying out essential proposed alteration**	**Approved suggestion and final design documentations**
8th	**Manufacturing**	**Manufacturing prototypes and the zero-lot**	**Full Production Documentations**