THE ORGANIC ANALOGY IN INDUSTRIAL DESIGN

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CHAPTER I INTRODUCTION

This theses is an examination of the analogies made between the industrial design process, natural organisms and the evolution of these organisms. The various analogies will be analysed and evaluated as to their success and usefulness to the designer.

Since the beginning of the nineteenth century, various analogies have been made between biology and the applied arts. Some of these were concerned mainly with architecture, but as industrial designers are often influenced by theories proposed by architects as well as other deisgners, these theories have been included for the sake of a complete analysis.

In order to analyse the design process and the resultant designs, it is necessary to define the process and the elements which affect it. This will be done in Chapter Two with the help of the 'Function Complex'. This was proposed by the design theorist, Victor Papanek (b. 1925) in his book Design for the Real World (1972). The 'Function Complex' dispells the myth that 'form follows function' and proposes that design follows the functions of 'method, use, need, telesis, aesthetics and association'. These six elements completely encompass all the aspects of a design and can be applied to any design project.

In Chapter Three the term 'Organic Design' will be defined in the context of this thesis. Then the various types of organic analogy will be identified and analysed in terms of their success and usefulness to the industrial designer.

The first group of analogies is 'anatomical', which compares the component parts of an artifact to the individual organs of an organism. The idea of functional 'coherence' or 'integrity', based on the theory of the 'correlation of parts', proposed by Georges Cuvier (1769 - 1832), is applied to the arrangement of components in an artifact.

The second group of analogies is 'Ecological', which proposes that the environment of an artifact has the same determining effect on the design of the artifact, as the natural environment has on plants and animals.

The third group of analogies is 'Evolutionary'. The analogy is based on the evolutionary theory of Charles Darwin (1809 - 1882) and proposes that the slow process of 'craft evolution' which occurs in primitive societies, is superior to the modern design process. There are several theories which propose a way in which an 'evolutionary' design approach could be applied in a modern social, economic and cultural climate. These were, firstly, the philosophy of 'purism' proposed by Le Corbusier (1887 - 1965) and Amadee Ozenfant (1886 - 1966). Secondly, there is the theory of 'design as a process of growth.' Thirdly, there is the theory of 'biotechnics', which involves the copying of natural principles and structures in the design of 'functional' artifacts. Finally, there is the approach which I have chosen to call 'bio-aesthetics'. This invented term refers to the approach which uses natural form as a model for the design of artifacts in the areas of 'aesthetics' and 'association'.

Of all these analogies between biology and design it will be shown that many fail and some are successful and useful to the designer. The successful analogies are firstly the 'Ecological' theory that 'forms are defined by the functions which are defined by the environment'. This theory is a restatement of Papanek's 'Function Complex'.

Secondly, there is the 'Bio-aesthetic' approach, derived from the 'Evolutionary' analogy and which works in the areas of 'aesthetics' and 'association'.

In Chapter Four the work and theories of Dr. Christopher Dresser (1834 - 1904) will be examined.

This analysis will show that Dresser was a key figure in nineteenth century design, who made successful use of organic analogy, producing radical designs in metal, ceramics and glass.

His early use of the ideas of organic analogy places him as one of the first designers to successfully adopt this approach and apply it to the design of artifacts for large scale machine production. In contrast to the ideas of the 'Arts and Crafts' movement, Dresser embraced mechanisation and mass production as a vehicle which brings 'art' to the 'masses'. This places him as an early 'Industrial Designer'.

Dresser first studied botany before concentrating on design as a profession. It is from his botanical studies that he takes the inspiration for many of his works. He uses 'conventionalised' forms, which are idealised and simplified plant forms, to convey the energy, vitality and dynamism he seeks in design. His motto 'Truth, Beauty and Power' sums up his requirements for design. 'Truth' is gained from a scientific approach to botany and the design process. 'Beauty' is attained through the use of nature as an inspiration for design. 'Power' is given by the designer's knowledge, which brings 'Truth' and 'Beauty' to the lives of other people.

CHAPTER II DESIGN : THE FUNCTION COMPLEX

This chapter will discuss the way in which the design of an artifact is affected by aspects of its creation, purpose and existence. These aspects will be identified and analysed. A basis will be made for the analysis and evaluation of theories on design, which will follow in succeeding chapters.

> All men are designers. All that we do, almost all of the time, is design, for design is basic to all human activity. the planning and patterning of an act towards a desired, forseeable end, constitutes the design process.
> (Papanek, 1971, p.3)

Design is a process which aims to arrange and compose the elements of an art or artifact in meaningful relationships. Design is a problem solving process and as such, produces an infinite variety of solutions to a design problem. The suitability of each solution depends on its 'meaning' relative to the 'purpose' of the design. The 'purpose' of a design has often been taken to mean its 'utilitarian function'. This leads to the theory of 'Functional Determinism' ; that the design of an artifact is determined by its 'use'.

The most famous statement of this theory is the almost notorious slogan 'Form Follows Function'. This was invented in the 1880s by the American architectural theorist Louis Sullivan (1856 - 1924).

It is obvious that design or 'form' is related to 'use' or 'function' in some way, but the wording of Sullivan's statement suggests that 'Form' is determined solely by utility. This is an unlikely situation.

In his book Design for the real world, Victor Papanek (b. 1925) proposes that design or 'form' is determined by six elements of which 'use' is just one. The remaining elements are 'method', 'need', 'telesis', 'aesthetics' and 'association'. Papanek calls this theory the 'Function Complex' (Fig. 1) and continues to define each of the six elements :

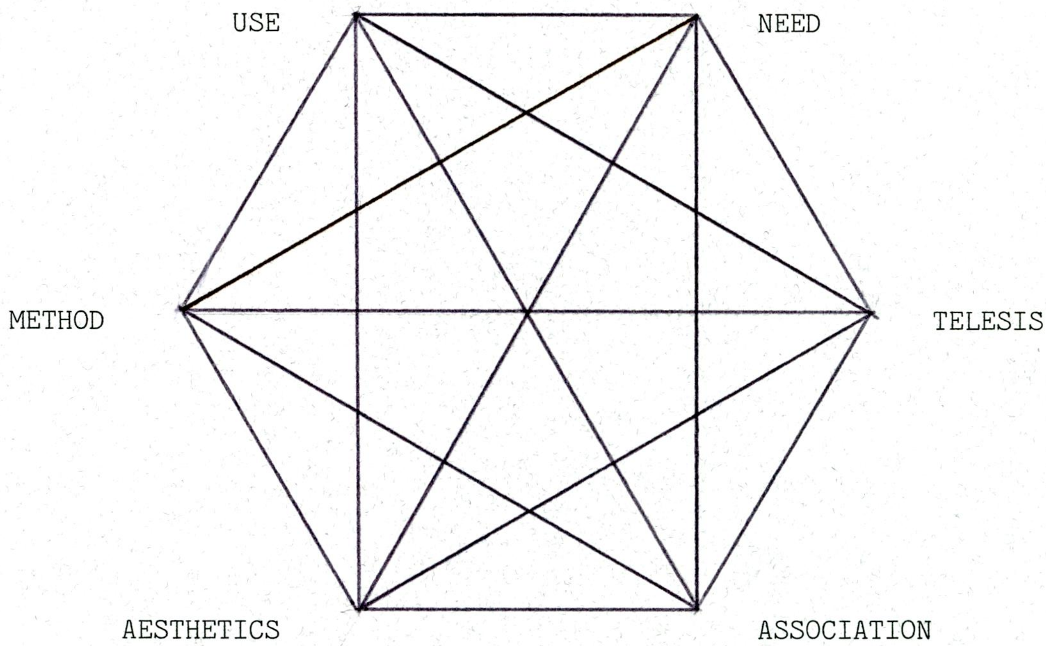

Fig. 1 PAPANEK'S FUNCTION COMPLEX

METHOD : 'The interaction of tools, processes, and materials' (Papanek, 1971, p.6). Design is affected by the methods of manufacture to be used, the materials avilable and the skill of the manufacturer. Papanek extends his definition to include guidelines for 'good method':

> An honest use of materials, never making the material seem that which it is not, is good method. Materials and tools should be used optimally, never using one material where another can do the job less expensively, and/or more efficiently. (Papanek, 1972, p.6)

The application of 'good method' will lead to an economic, efficient, but perhaps conservative design.

USE : This is the requirement of 'utilitarian function' which involves structural, mechanical, scientific and other physical principles.

> A vitamin bottle should dispense pills singly. An ink bottle should not tip over. A plastic-film package covering sliced pastrami should withstand boiling water. (Papanek, 1971, p. 9)

NEED : The term 'need' is distinguished from 'wants'.

> The economic, psychological, spiritual, technological and intellectual needs of a human being are usually more difficult and less profitable to satisfy than the carefully engineered "wants" inculcated by fad and fashion. (Papanek, 1972, p. 11)

'Need' is the reason for the design of an artifact and may involve any of the other five elements of the 'Function Complex'. 'Needs' are a broader form of requirement. For example, there may be a 'need' for a design which better serves the requirements of either 'use', 'method', 'telesis', 'aesthetics' or 'association'.

TELESIS : This is the element of a design which links it to its context.

> Telesis : the deliberate, purposeful utilisation of the processes of nature and society to obtain particular goals. The telesic content of a design must reflect the times and conditions that have given rise to it, and must fit in with the general human socio-economic order in which it is to operate. (Papanek, 1971, p. 12)

If a design is removed from its intended context the requirements of the 'Function Complex' will change in both content and in order of importance. Thus, the design may become totally inappropriate.

ASSOCIATION : This is the psychological conditioning which provides us with a mental image of, or a feeling towards a given value or feature. These mental relationships, which are usually formed sub-consciously, can be used to relate a design to its context by apparently giving it the attributes associated with some other object, artifact or experience.

Association can be used to make a new idea more acceptable and successful by relating it to its context. Association can evoke feelings of beauty, grace, power, strength, speed, aggression, danger (the list is endless), by creating psychological relationships.

> The "Lettera 22" portable typewriter by Olivetti establishes an immediate aura of refined elegance, precision, extreme portability and business-like efficiency, while its two-toned carrying case of canvas and leather connotes "all-climate-proof". (Papanek, 1971, p. 16) (Fig. 2)

AESTHETICS : 'set of principles of good taste and appreciation of beauty' (Concise Oxford Dictionary, 1982) The designer works in the area of 'aesthetics' through the use of principles he has learned and through intuition. 'Aesthetics' is a combination of abstract psychological values which work to evoke the perception of 'beauty' or 'ugliness'.

Fig. 2 THE LETTERA 22 TYPEWRITER BY OLIVETTI (1950)

Aesthetic qualities are those which are perceived by the senses of sight, hearing, touch, taste and smell. In an artifact, these aesthetic qualities are perceived in form, colour, texture, material,etc.

Papanek's 'Function Complex' can be used to analyse the relationship between an artifact and its requirements, by making an evaluation as to how well the artifact satisfies each of the requirements of the 'Function Complex'.

The 'Function Complex' can also be used to evaluate a design theory or approach, by analysing the way in which each of the six elements is catered for. An industrial design approach must allow flexibility of the priorities given to each area, otherwise it will not be suitable for application to a variety of design projects.

Perhaps Sullivan's slogan should be amended to 'Form Follows the Function Complex !'

CHAPTER III ORGANIC DESIGN

This chapter is concerned with, firstly, the definition of the term 'Organic Design' in the context of this thesis.

Secondly, with a survey of the different analogies made between design and nature.

Thirdly, the ways which nature is used as a model for the form and structure of artifacts and as a model for design approaches.

(i) Organic Design : In the context of this thesis the term 'Organic Design' is the study of natural organisms, either animal or vegetable and the natural evolution of these organisms which leads to theories on, and approaches to, the industrial design process.

It is usual that the biological or botanical theories are formulated first by specialists in that field of science. These theories become noticed by writers on architecture and design and are used as the basis for analogies between nature and design. Sometimes it is in an attempt to make the design process more scientific and in other situations a more expressive or artistic result is intended.

(ii) The first group of analogies is 'Anatomical'. It compares the component parts of an artifact to the individual organs of an organism.

The basis for this analogy was formulated by the French anatomist Georges Cuvier (1769 - 1832) in the early 1800s. He believed in the unalterable, functional integrity of the organism, that the various organs and parts all play necessary and complementary roles in supporting the animal's actions and way of life.

Cuvier formulated two anatomical rules, 'The Correlation of Parts' and 'The Subordination of Characters'.

By 'The Correlation of Parts' Cuvier meant the necessary functional interdependence between various organs or systems of an organism.

> Respiration supplies oxygen which being transferred through the lung walls to the blood is then circulated throughout the body ; the circulation of the blood depends on the action of the muscular pump of the heart ; this muscular contraction is controlled through nervous impulses from the brain ; and so on. The presence of one organ or structure would necessarily imply the presence of one or several others and any change in one would imply a correlated change in others. (Steadman, 1979, p.35)

For Cuvier the correlation of parts became the basis for a whole anatomical methodology, by noting the repeated occurrence of certain relationships between organs and relating them to the specific habitats and ways of life of animals, it would be possible to formulate the laws governing such relations with scientific accuracy.

The second rule, the 'Subordination of Characters' meant that certain organs or systems had greater functional importance to the organism than others and could thus be arranged in order of importance.

> Cuvier changed his mind several times about the ranking of the bodily systems, thinking initially that reproduction and circulation were foremost. Later he saw digestion as being most important, and finally he came to give first place to the nervous system. (Steadman, 1979, p.36)

The implication of these two rules, but particularly that of the 'Correlation of Parts' was that the occurrence of certain relationships of organs and systems,in particular types of organisms, could be related to the different environments of these particular organisms.

It was Cuvier's rather ambitious claim that the experienced anatomist, with the aid of his theoretical rules, would be able to reconstruct the form of an unknown animal from limited fragmentary remains and determine logically which bones belonged together. Missing parts could be theoretically reconstructed and even the creature's way of life could be deduced.

It was not until after Cuvier's death in 1832, that the connection was made between Cuvier's theories on biology and the design theories of the time.

> The principles of construction can be learned from the study of the skeletons and skins of animals and bones.
> (Greenough, 1852)

In 1881, Leopold Eidlitz published The Nature and Function of Art, more especially of Architecture. In this book, he sets down his architectural theories, which are focused on questions of structure. Eidlitz frequently refers to the building as an 'organism' and refers to separate constructional elements as 'subordinate structural organisms'. He claims that certain elements of thirteenth century Gothic architecture such as the 'pier', the 'pinnacle' and the 'flying Buttress' are particularly expressive of and correspond to their real function.

Montgomery Schuyler, a contemporary of Eidlitz also wrote on the analogy between architecture and nature and, specifically, Cuvier's rule of the 'Correlation of Parts'.

> This character of the organisms of nature is shared by at least one of the organisms of art. A person sufficiently skilled in the laws of organic structure can reconstruct, from the cross section of the pier of a Gothic cathedral, the whole structural system of which it is the nucleus and prefigurement. The design of such a building seems to be worthy, if any work of man is worthy, to be called a work of creative art. It is imitation not of the forms of nature, but of the processes of nature. (Schuyler, 1894, p.77)

In these analogies, Cuvier's method is used to convey the idea that the structural framework of a building forms a coherent and co-ordinated system in which the elements interact as loads are transferred from one to the next.

In the 1920s Le Corbusier (1887 - 1965) takes the analogy a stage further, by comparing the physiology of breathing to the ventilation of a building, the nervous system to electrical networks, the bowels to sewer pipes and refuse systems and, his most favourite analogy, the comparison of the circulation of blood to the circulation of people and traffic.

These analogies have contributed to the idea of 'Functional Determinism', that the utilitarian functions of artifacts serve to define their forms in a deterministic way. This is where the analogy fails, as can be seen from Papanek's 'Function Complex', there are many more requirements of an artifact which influence the form the designer gives it other than the requirement of 'use'. The forms of organisms may be largely defined by 'use' but an artifact may also be affected by 'beauty for the sake of beauty', luxury, extravagance or economy of cost, shortage of materials, lack of skill or tools for manufacture.

The other idea resulting from the anatomical analogy is that the component parts of an artifact are interdependent and that they play complementary and necessary roles in supporting the existence of the artifact. This theory may be true but it does not mean that there is only one possible solution to a design problem. There may be a wide choice of alternative combinations which will satisfy the requirements of 'use', 'method', 'need', 'telesis', 'aesthetics', and 'association'. Also, when function is taken to mean the 'Function Complex', a 'yes' or 'no' answer to the question 'does it function?' is not sufficient. There are likely to be many design alternatives which will better satisfy the 'Function Complex' in some particular area.

(iii) The next group of analogies is 'Ecological'. It sees the appropriateness of designed objects for their 'functions' as being equivalent to the fitness of animals or plants for their environment. In other words, the environment of an artifact has the same deterministic effect as the environments of animals and plants.

In Cuvier's anatomical theories, the co-ordination of the parts of an animal's body were seen to be associated with the external conditions or environment, creatures living on certain kinds of food would have teeth and digestive organs to match, animals living in water, on land and in the air would have appropriate organs of locomotion. Evidently the separate organs of the body can be seen to serve definite functions and these functions are related to the creature's environment. This is the basis for the 'Ecological' analogy which claims that in both organisms and artifacts, form is related to the functions which are determined by the environment. The degree to which form suits or is appropriate to these functions and environment, can in both cases, be expressed in terms of fitness.

> In nature, forms are the outcome of environment. Environment determines function, and forms are the result of function. (Eidlitz, 1881,p.358)

This principle is only true if 'function' is taken to mean the 'Function Complex'. If this is the case, the principle is simply a restatement or Papanek's 'Function Complex', the two theories having a similar conclusion.

If the 'Ecological' analogy is developed further, the question arises as to what exactly the 'environment' of an artifact refers to. Again a connection can be made to Papanek's 'Function Complex'. The environmental elements for the artifact would be 'method', 'use', 'need', 'telesis', 'aesthetics', and 'association'.

If this analogy is examined, it is found that, for artifacts 'method' includes tools, processes and materials. Obviously, these tools and processes are not in any way similar to the growth or 'manufacture' of natural organisms. But the same principles apply to the strengths and limitations of materials for both organisms and artifacts.

The analogy with 'use' has been discussed earlier in part (ii) of this chapter, concerning the anatomical analogy and 'Functional Determinism'. It was found that an artifact is not as predominantly defined by 'use' as an organism is.

The analogy with 'need' and 'telesis' are more indeterminate and abstract. For the artifact, these are the social, economic and cultural environmental elements. For the organism a highly complex cultural and social environment may or may not exist, depending on the species in question. The complexity and importance of these cultural and social elements will also vary with different species.

'Aesthetics', in terms of beauty, can serve as a psychological attraction both to an artifact and an organism. This is especially obvious in the reproductive sequence of animals. The use of aesthetic principles and ideas can make an artifact beautiful, exciting and 'pleasing to the eye'.

The principles of psychological 'association' can be seen to operate in the acquired appearance of both organisms and artifacts. Papanek has shown us how 'association' affects the design of artifacts, our psychological conditioning provides us with a mental image or feeling towards a given value or feature. In nature, association can serve as a defence mechanism, the colours or patterns of an organism can be associated with danger or aggression and can serve to ward off predators. Association can act as a form of communication between species. For example, the flower advertises its nectar to insects through its colour, pattern and smell.

(iv) The third group of analogies made between nature and design are 'Evolutionary'. This theory describes the design of artifacts, especially in primitive societies and in the craft tradition, in terms of a sequence of repeated copyings, with small changes made at each stage. The reults of this copying process are subjected to a testing and selecting process when the object is put into use.

In his book On the Origin of the Species by means of Natural Selection or the Peservation of Favoured Races in the Struggle for Life, Charles Darwin (1809 - 1882) proposed his radical theory on evolution. Darwin observed that, in all species, there existed a struggle for survival. This struggle went on in the competition of young to reach maturity and also included a competition for reproductive advantage.

Darwin also observed that, within any one species, there existed variations, no two individuals were identical. Some of these variations may give an advantage in the struggle for survival. As a result a higher proportion of those individuals possessing advantageous variations would achieve full development and reproduce, while the less suited individuals would fail to do so.

Where such a variation is passed on through inheritance then the advantageous variations would tend to spread throughout the population and the disadvantageous variations would tend to disappear. This is the process of 'Natural Selection' or 'Survival of the Fittest', by which the forms of organisms are continually changing and adapting to their environments. It is not the forces of the environment which physically mould the organism from the outside, but a series of spontaneous changes from within the organism which are 'tested' against the environment. The improvements are naturally selected and preserved.

The first step in making an analogy between Darwinian evolution and the technological evolution of artifacts is to equate genetic inheritance with the copying of artifacts. This analogy is particularly appropriate to the craft traditions of primitive societies, as there tends to be considerable conservatism in the methods of these craftsmen, reinforced by traditions, customs and 'taboo'. This situation is the technological counterpart of the stability of organic form conferred by genetic inheritance.

But usually the craftsman's copy is not perfect in every detail, perhaps due to lack of skill or the limitations of the available tools and materials. Then, when the artifacts are put into use, the copies which have a slightly superior variation in form or manufacture will tend to be preserved and selected for successive copyings.

It is possible that a variation will be introduced accidentally 'at random' and that the mechanism of selection will ensure the spread of the advantageous and the elimination of the disadvantageous.

A necessary feature, in both the organic and the artificial situation, is that there should be a long period of time over which the evolutionary process can take its course, and that, during this time, the environment of the organism and the artifact should not be subject to any extreme changes.

The essence of Darwin's theory lies in 'Trial and Error', the 'Trials' being provided by variations and the 'Errors' being detected and removed by selection. Darwin had shown how similarities due to hereditary origin could be connected to similarities due to adaptation to similar environmental conditions. Adaptation was produced through trial and error and the successful results retained and passed on through heredity. An example of technological evolution in architecture is made by James Fergusson in his book An Historical Enquiry into the True Principle of Art, more especially with reference to Architecture. date

> The rude and heavy Norman pier was gradually lightened and refined into the clustered shaft of the later Gothic ..... the low rude waggon-vault expanded into the fairy roof of tracery, and the small timid opening in the wall, which was a window in the earlier churches, became a "transparent wall of gorgeous hues". (Fergusson, 1849, p. 156)

Fergusson gives another example, concerning the development of the 120-gun warship up to the 1850s.

> We have a steady progression through eight centuries, and it would be difficult to calculate how many brains of all calibres, not only in every part of Europe but of America also, it has required to produce this great result. We neither care nor know who did it, more than we do know or should care who built our great cathedrals. They are the result of the same system, and not individual inventions, and can only be reproduced by causes similar to those which first created them. (Fergusson, 1849, p. 158)

Fergusson claims that technological progress in all areas is of the same nature, that sometimes an inventor appears and makes great advances, but all the time thousands of anonymous craftsmen and mechanics are making steady, slow progress. But, when over a century, the talents, taste and experience of a hundred or even thousands of ordinary men are built into a design, the result will be something that not even an individual of the greatest genius could match.

In 1883 the Pitt Rivers Museum was established in Oxford. The founder was Lieutenant-General Lane-Fox Pitt-Rivers (1827 - 1900). It was his idea to make a collection of implements, tools and other artifacts which would be scientifically organised according to an evolutionary plan. The main inspiration for this idea came from his military work. He had been impressed by how gradual and slow the process of the development of firearms was. He concluded that the same slow evaluation might be found in other kinds of tools and artifacts.

In an evolutionary scheme (Fig. 3) which Pitt-Rivers compiled, the artifacts were arranged chronologically, showing the slow metamorphosis taking place.

It can be seen that in the evolution of both organisms and artifacts, it is possible that the function evolved at the same time as the form does. Darwin's example of this principle is the evolution of lungs in land creatures, from the swimbladder in fishes. The swimbladder is an organ which adjusts the fish's buoyancy, it is located near the gills in the fish's body and is supplied with air through a duct. According to Darwin, it is the swimbladder which has evolved into the lungs of land animals.

It can also be observed that certain organs in animals have evolved to become useless, for example, the claws of a stag beetle. These vestigial organs remain, purely as decoration, because they cause no harm to the animal. A technological example of 'vestigial' components in artifacts is made by Le Corbusier in L'Esprit Nouveau, p. 13 (1921). A series of drawings (Fig. 4) shows the lingering influence of carriage design through the car designs of the early twentieth century.

For designers and architects, such as Le Corbusier, the study of the evolution of artifacts could reveal principles or methods which might then be consciously applied in contemporary practice. But, the problem was that long periods were needed for the evolutionary process to work. The accelerating rate of industrial and social development in the twentieth century would mean that the 'environment' or 'context' would change too quickly for evolutionary design methods to work.

There were several theories proposed, suggesting a way in which evolutionary design methods could be made to work in a modern environment.

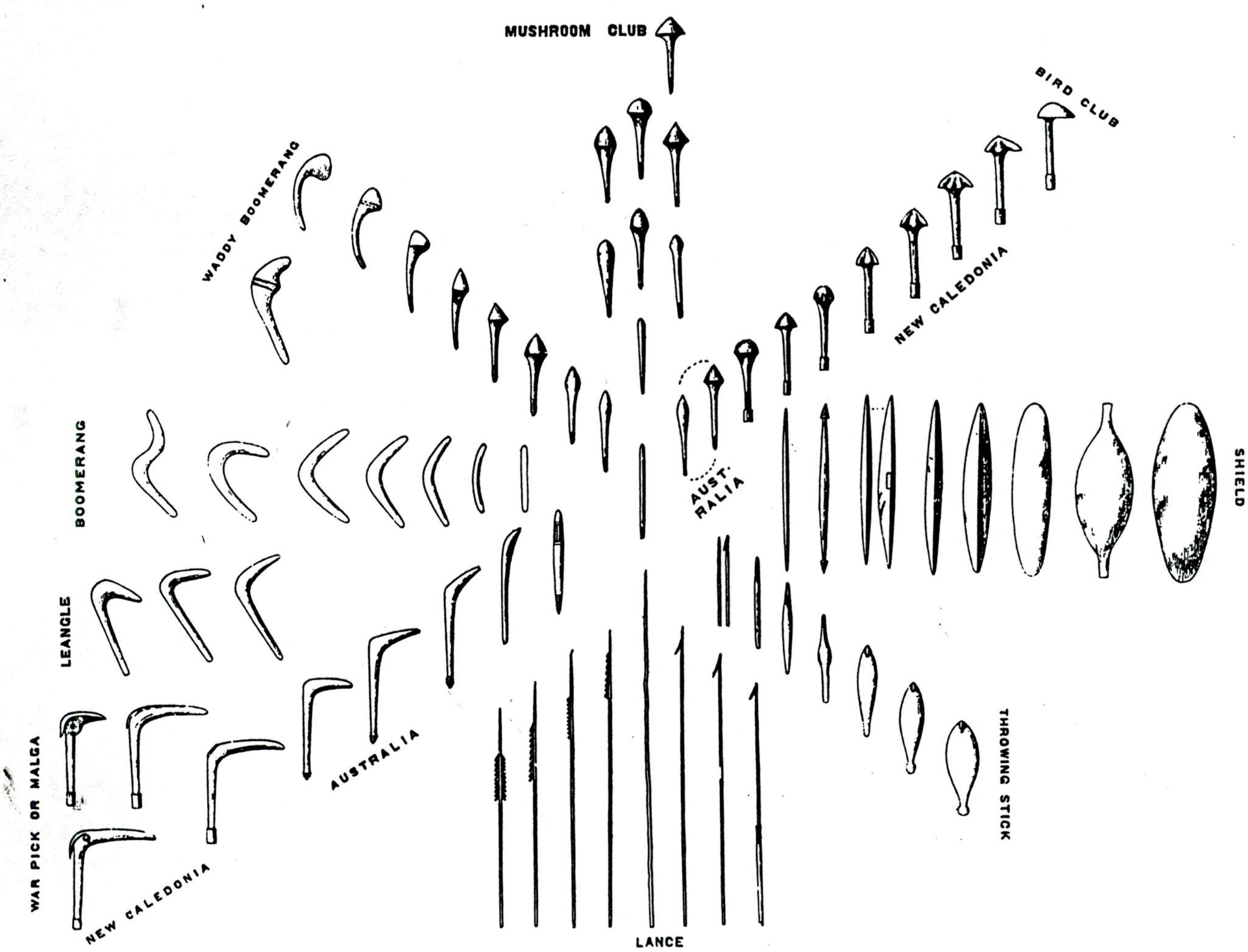

Fig. 3 THE EVOLUTION OF AUSTRALIAN ABORIGINAL WEAPONS

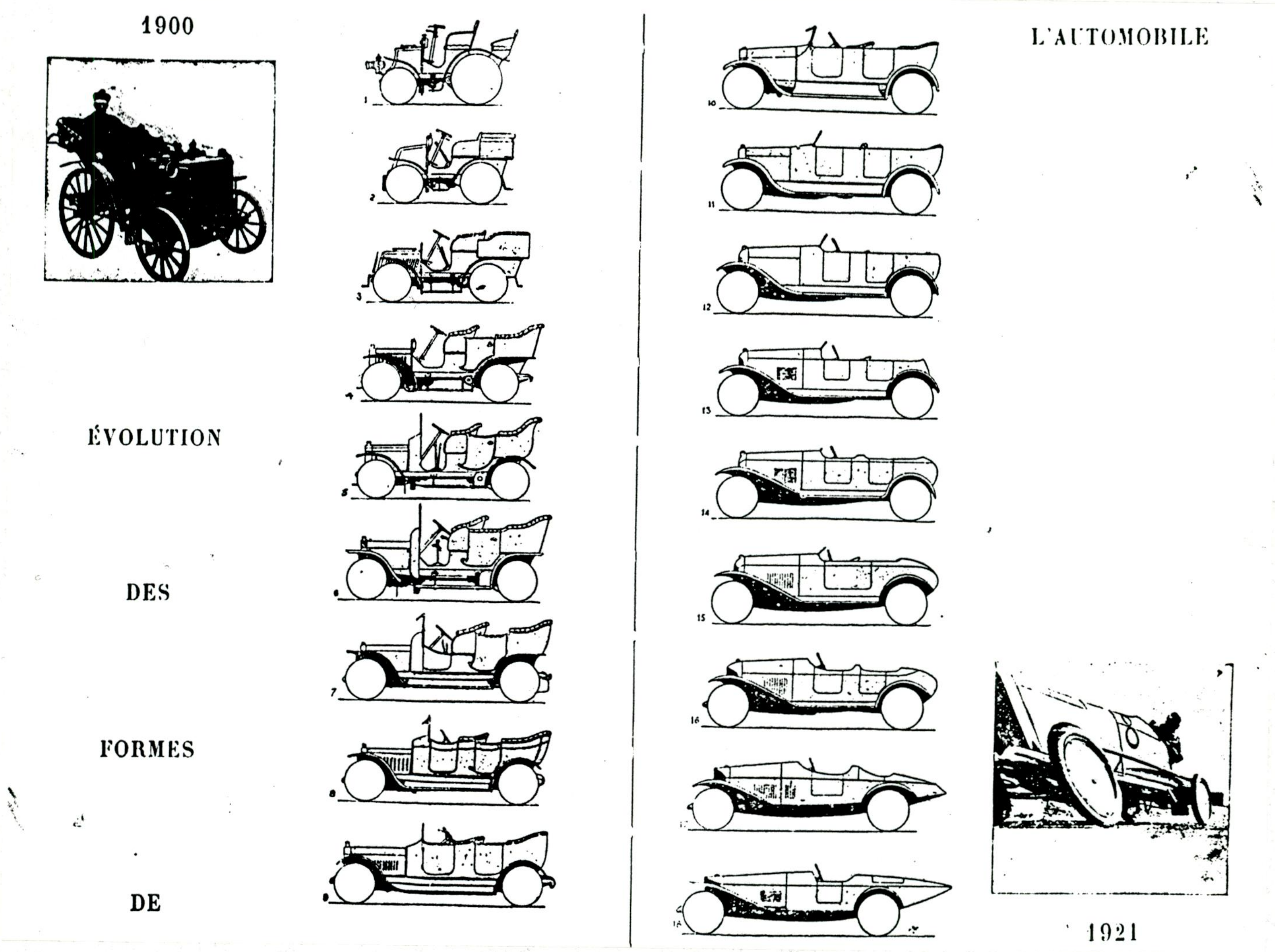

Fig. 4 THE EVOLUTION OF THE CAR, 1900 - 1921

(A) The first of these theories was embodied in the philosophy of 'Purism'. The leading proponents of this theory were Le Corbusier and Amadée Ozenfant (1886 - 1966). In their book La Peinture Moderne (Paris, 1925) they announced the existence of 'objets-types'. These were artifacts which had evolved to a perfect standardised form. The Purists called this theory 'The Laws of Mechanical Selection'.

> This establishes that objects tend towards a type that is determined by the evolution of forms between the ideal of maximum utility and the satisfaction of the necessities of economical manufacture, which conform inevitably to the laws of nature ...... This double play of laws has resulted in the creation of a certain number of objects that may be called standardised. (Ozenfant and Le Corbusier 1925, p. 167)

Another aspect of the purist theory is that mechanical evolution and natural evolution are similar processes and conform to identical natural laws. Thus, the aesthetic qualities which we see in machines and in organisms have a common origin.

The failure of the Purist theory is caused by the refusal to account for the rapid rate of development in materials and production technology which does not allow the time or the stability of the 'environment' necessary for the evolutionary process to work.

> The tools that man has made for himself, which automatically meet the needs of society, and which till now had undergone only slight modifications in a slow evolution, have been transformed all at once with an amazing rapidity. These tools in the past were always "in man's hands". Today they have been entirely and formidably re-fashioned and for the time being are out of our grasp. (Le Corbusier, 1923, p. 251)

Le Corbusier gives no answer to this problem and so the Purists evolutionary theory cannot be successful in a contemporary social, economic, cultural and technological environment.

(B) The second theory, which proposes the 'speeding up' of technological evolution involves the idea that the designer might imitate, not the evolution of a species, but rather the growth of an individual organism.

As an organism grows it interacts with its environment and its form becomes progressively more complex. The parallel in design is the development from the basic concept into a completely thought out and finished design. In this case the environment of the artifact is the critical assessments and evaluations made by the designer.

But it is a fact that the growth of an organism follows a fixed schedule and that the 'design information' is carried in the genetic material of the organism. A more accurate analogy would be to compare the growth of an organism to the manufacture of a finished design. The 'genetic information' are the plans for the manufacture of the artifact. Unfortunately, this is an analogy between 'growth' and 'manufacture', not between 'growth' and 'design'.

(C) There is a third method in which an 'organic' design method might escape the problem of the long periods of time required by the evolutionary process. This approach has become known as 'Biotechnics', the main principle of which is that nature has already made a great variety of inventions in the 'design' of organs and organisms, and that these inventions solved structural, mechanical, chemical and electrical problems in ingenious ways. Through a diligent study of nature, man would find the solutions to all his functional design problems, natural models could simply be copied in the design of artifacts. Nature had already spent the long periods of time for organic evolution to work ; man would be taking advantage of this time already spent.

This theory relies on the assumption that the results of an evolutionary process are superior to those of a revolutionary, inventive one. This assumption may be correct in the biological situation where the environment is constant and changing slowly. But, when an organ system is copied in the design of an artifact it is removed from the environment to which it evolved and its 'design' may not suit its new context. Thus the 'biotechnical' approach does not produce superior results to an original design method which does not rely on the copying of existing structures.

(D) There is an extension of the 'biotechnical' approach which could be called 'bio-aesthetics'. This method also uses organic form as a model for the design of artifacts, but the emphasis is on 'aesthetics' and 'association' rather than 'utility'.

The 'bio-aesthetic' approach is evident in many ancient artifacts. Man has often shown a desire to depict his natural environment in abstract and representational ways. Organic decoration was applied to artifacts, perhaps to give the artifact the values associated with the organism, such as speed, grace, beauty, strength or ferocity.

Throughout the nineteenth century the 'bio-aesthetic' approach was prevalent in the design of silverware, furniture and other artifacts. With the emergence of the 'Arts and Crafts' movement in the 1860s, there came an emphasis on naturalistic, representational decoration, based on plant forms. This style of decoration aimed to use the 'aesthetics' of nature exactly as they were found. This idea was mainly a reaction against the mechanical, geometric symmetry found in products of the industrial revolution.

When, in the 1890s, 'Art Nouveau' became the popular style, the form and decoration of artifacts became more idealised and abstract. Nature was reduced to its essential lines, sometimes it was so abstracted and distorted that the original source of inspiration was hardly recognisable.

The 'Art Nouveau' designers used the evocative force and symbolic quality of line to convey rhythmic quality and organic growth. Lines could be delicate, aggressive, flowing, rippling, undulating and dynamic.

The principles of 'Bio-aesthetics' work successfully on an 'associational' basis. The direct representation of natural forms can give an artifact natural or organic characteristics through psychological association and it can provide recognisable features of interest making an artifact more 'friendly' and 'acceptable'.

The abstraction of natural forms can be used to bring about associations with the attributes of an organism without the direct suggestion of the organism. The organic model may become so abstract that it is unrecognisable and so the beauty of the form relies purely on the abstract psychology of perception, the movement of the observer's eye as the form is analysed, the tension and movement apparently created by the forms and lines.

In summary of the discussions in this chapter :

It was found that there are two principles derived from the 'anatomical' analogy. The first is the theory of 'functional determinism', that the utilitarian functions of artifacts serve to define their forms in a deterministic way. This principle was found to be false, as the forms of artifacts are also defined by 'method', 'need', 'telesis', 'aesthetics' and 'association', as discussed in Papanek's 'Function Complex'.

The second principle derived from the 'anatomical' analogy is the theory of 'Correlation of Parts', that the components of an artifact play complementary and necessary roles in supporting the existence of the artifact. This principle was found to be true, but it does not affect the designers choice of alternatives.

The 'Ecological Analogy' has also contributed two principles to the theory of design. The first of these is the theory that the form of an artifact is defined by the functions which are defined by the environment. This principle is similar to Papanek's 'Function Complex' and is a useful guide to the designer.

The second ecological theory is the analogy between the environments of organisms and the environments of artifacts. This analogy does succeed in areas of the 'Function Complex', which is used as a definition of environment, thus the theory is false.

The 'Evolutionary' analogy has led to four approaches to the design process. The first of these is the philosophy of 'Purism' which proposes the use of the 'Evolutionary' design process. But the 'Purists' cannot provide a solution which allows for the rapid changing of the modern environment for the artifact.

The second 'Evolutionary' approach proposes that the designer should imitate, instead of evolution, the growth of an individual organism. This idea fails because the 'design' of the organism is contained in the genes and is unchangeable during the growth process.

The third 'Evolutionary' method is the 'Biotechnical' approach, which copies the principles and structures of nature in the design of functional artifacts. This approach may provide results but they are not necessarily superior to an original, non-eclectic approach.

The fourth 'Evolutionary' method, which is similar to 'Bio-technics' is the 'Bio-aesthetic' method. This approach takes the 'aesthetic' qualities found in nature (form, colour, texture, etc.) and applies them to the design of artifacts in both abstract and representational ways. This can result in the perceptions of beauty, grace, speed or power either 'through' purely abstract aesthetic perception or through psychological association.

The conclusion of this chapter is that the only 'organic' analogies which are successful and therefore useful to the designer are, firstly, the Ecological theory that forms are defined by the functions which are defined by the environment (a restatement of Papanek's 'Function Complex'). Secondly, the 'Bio-aesthetic' approach, derived from the 'Evolutionary' analogy which uses natural forms as 'aesthetic' and 'associational' models.

CHAPTER IV CHRISTOPHER DRESSER (1834 - 1904)

This chapter of the thesis will examine the works and theories of Dr. Christopher Dresser, firstly as a key figure in 19th century design.

Secondly, as a botanist and a design theorist who put forward radical and revolutionary ideas that fully accepted the machine and the approach to modern mass production methods. He placed great importance on simplicity, utility and economy. He argued that all decorated objects should appear to be what they are and should not attempt to be what they are not. These theories anticipated the basic philosophy of the 'Bauhaus' more than five decades before its formation.

Thirdly, his design work will be surveyed and an analysis will be made of his use of organic analogy, making Dresser a pivotal figure in the history of design related to nature.

In 1847 Dresser became a student at the Government School of Design, where he stayed for seven years as both student and a lecturer. It was during this time that Dresser became interested in 'artistic botany' and the basis was made for his motto 'Truth, Beauty and Power !'

Dresser was influenced by the theories of Richard Redgrave (1804 - 1888) who was director of the school during Dresser's time there and who gave a lecture on 'The importance of Botany to the ornamentist'. Redgrave, along with Augustus W.N. Pugin (1812 - 1852), was probably one of the most persuasive writers on design around the middle of the 19th century. They argued that the general laws of vegetation were parallel to the essential principles adopted by artists. They put forward the idea of flat, stylised plant ornamentation as opposed to the naturalistic relief decorations popularised by John Ruskin (1819 - 1900) who, along with William Morris (1834 - 1896), was a leading figure in the arts and crafts movement.

Also in contrast to the views of Ruskin and Morris, Dresser stressed the importance of design and modernism, he fully accepted the machine and the methods of production it brought with it.

Dresser decided to specialise in botanical studies and between 1854 - 1868 he lectured at the School of Design on subjects such as 'The best mode of investigating the form and structure of plants with a view to the treatment in ornament'.

His books on 'The Rudiments of Botany' (1859), 'Unity and Variety as deduced from the Vegetable Kingdom' (1859) and 'The Popular Manual of Botany' (1860) earned him a notable reputation among botanists. In 1859 the University of Jena awarded him a doctorate in philosophy in consideration of the services he rendered to botanical science.

A notable feature of Dresser's botany was his interest in trying to reduce the plant to an orderly, geometric and symmetric structure. In 1862 Dresser published two books 'The Art of Decorative Design' and 'Development of Ornamental Art'. He also wrote an article for the 'Planet' magazine called 'On Decorative Art'. In these writings Dresser sets down his doctrine and principles on design with reference to many botanical examples.

Although he proposed that natural structures could be valuable inspiration for the designer, he warned his readers against an unduly accurate imitation of nature in the ornament itself. He declared that the source of inspiration must be used with care and after conscious revision, he stressed that plant forms should be 'conventionalised'.

> Conventionalised plants will be found to be nature delineated in their purest form, hence they are not imitations but are the embodiments in form of the mental idea of the perfect plant. (Dresser, 1862 (1), p.38)

Dresser developed his aesthetic theories to concern the beauty of a curved line, which he considered to be proportional to the complexity of its origin.

> A portion of the bounding line of an ellipse is more beautiful as a curve than the arc, for its origin is less apparent, it being struck from two centres. The curve which bounds the egg shape is more subtle than the elliptical curve, for it is struck from three centres. (Dresser (162 (1), p. 95)

He insists that lines should not cross one another and there should be a 'graceful flowing of line out of line'. (Dresser 1862 (1), p. 101)

These theories are directly related to his views on nature. He claimed that in young palms and tropical vegetation he discovered the energetic curve and the linear rhythm he was seeking.

Dresser's views on utility were also derived from his theories on nature. 'In vegetable nature the utmost regard to fitness is manifested'. (Dresser, 1862 (1), p. 117) He placed great importance on utility and said 'Utility must precede beauty'. (Dresser, 1862 (1), p. 137)

Once the requirement of utility had been satisfied, an analysis should be made of the materials to be used and finally the 'honesty to construction' should be considered, thus 'giving force to the intention of every part'. (Dresser, 1862 (1), p. 138)

His principle of 'honesty to construction' is derived partly from the botanical theory of 'the correlation of parts' proposed by Georges Cuvier, that the organs which make up an organism are interdependent and that there exists a coherence throughout the whole.

By 1868 Dresser had abandoned botany as a profession to concentrate on industrial design. He claimed it was the designers task to unite science, which equals truth, with art, which epitomises beauty. The superior 'knowledge' of the designer would give him the 'power' to 'lead on the minds of the less enlightened towards beauty and truth'. (Dresser, 1857, p. 364)

This was the basis for his motto 'Knowledge is Power' and led on to his central concept of design 'Reaching Truth and Beauty through Power.' (Dresser, 1857, p. 370)

> I have sought to embody chiefly the idea of power, energy, force or vigour, and in order to do this, I have employed such lines as we see in the bursting buds of spring, when the energy of growth is at its maximum and especially such as is to be seen in the spring growth of a luxuriant tropical vegetation. I have also availed myself of those forms to be seen in certain bones of birds which are associated with the organs of flight, and which give us an impression of great strength, as well as those observable in the propelling fins of certain species of fish. (Dresser, 1873, p. 17)

The other great inspiration for Dresser was his interest in Japanese art and design.

In 1877 Dresser travelled to Japan and spent several months visiting temples, shrines and centres of traditional manufacture. In his account of the visit to Japan, Dresser described the Japanese as :

> The only perfect metal workers which the world has yet produced, for they are the only people who do not think of the material, and regard the effect produced as of far greater moment than the material employed. (Dresser 1882)

Dresser became one of the leading figures in the introduction of 'Japanism' or the 'cult of Japan' to the West.

Throughout his designing career, Dresser took inspiration from both his extensive botanical studies and the elements he admired in Japanese design.

During the 1870s and 1880s Dresser was engaged as a designer by at least 30 of the most prestigious British manufacturers of all kinds of art industry. The remainder of this chapter will concentrate on an analysis of his work and the application of his theories based on his botanical studies.

The objects Dresser designed were intended for the domestic interior. The greater proportion of his designs were for glass, ceramics and metalwork. Of these, his designs for metalwork were his most revolutionary, suggesting little of the period in which they were created.

In his designs for metalwork Dresser uses many simple, geometrical shapes and a minimum of surface decoration. Yet he still manages to incorporate the sense of elegance and organic vitality that is such an element of his work.

His first recorded metalwork was produced by the Elkington Co. in Birmingham in 1865. His designs were regarded as a progressive novelty and clearly challenged the elaborate naturalism and historicism which was prevalent in Victorian silverware.

In his design for a sugar bowl (Fig. 5) Dresser uses an inverted cone shape for the body of the vessel. This form can be associated with the natural cone formed by a heap of sugar. But it also serves a practical purpose, as the bowl is emptied, the sugar gathers in the point of the cone, making it easier to remove with a tea-spoon.

Three almost 'frog-like' legs grow smoothly out of the cone, they crouch as if straining under the weight of the bowl's contents and are poised as if the bowl were about to 'waddle' across the table towards the tea drinker. The fact that there are three legs serves to make the bowl more stable, reducing the possibility of spilling its precious contents.

The only applied decoration is in the form of two beads around the rim. The existence of these beads allows the bowl to be made from thinner material, yet still possess sufficient strength, thus saving material and giving a 'fitter' and 'more athletic' design which doesn't rely on bulk for strength.

Perhaps the bowl could be seen as a small organism whose only purpose in life is to carry sugar and whose body has evolved to perfectly achieve this function. If such an organism existed, Dresser's design could be 'the embodiment in form of the mental idea of the perfect plant'. (Dresser, 1862 (1), p. 38)

In 1869 Dresser designed an electroplated tureen (Fig. 6) for the Elkington Co. The overall form is reminiscent of a 'spikey' chestnut. The central vessel is a soft round form with angular spikes for feet and handles 'growing' perpindicular to its surface. The lid sits as if it is sinking into the soft body of the vessel. The tureen seems like a soft, swollen fruit, sagging under the weight of the rich food it contains.

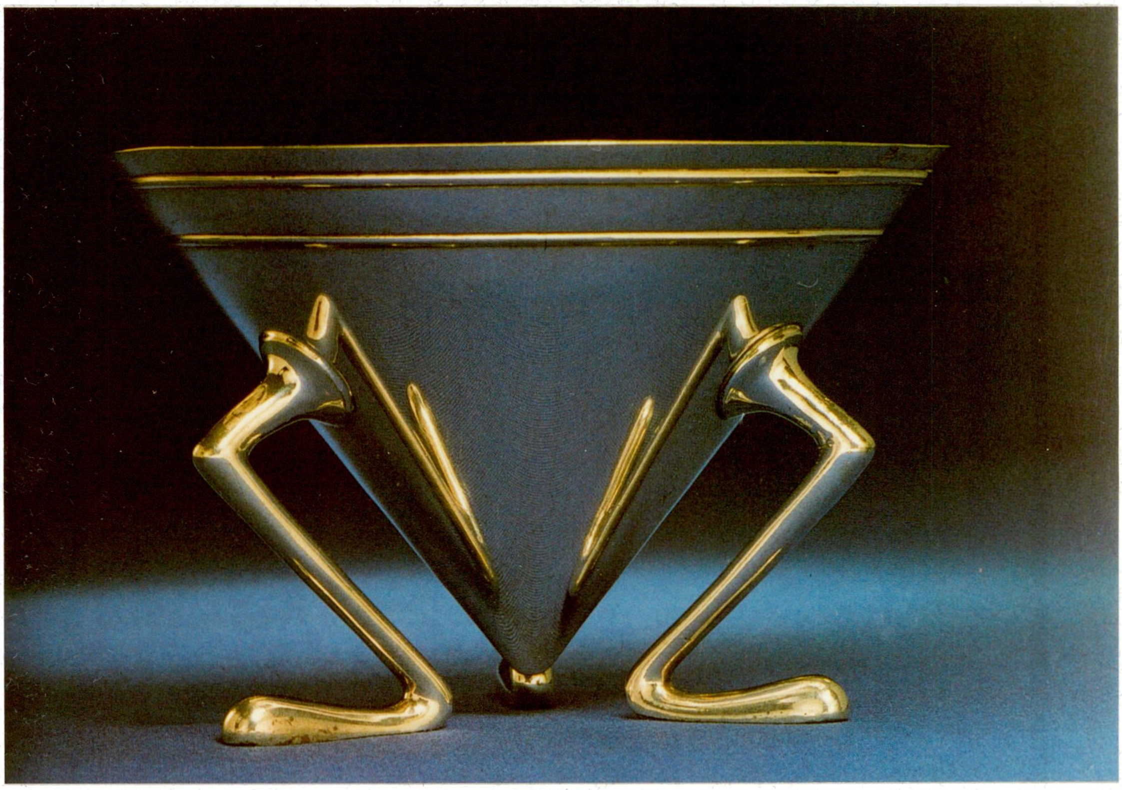

Fig. 5 DRESSER, C. SUGAR BOWL
THE ELKINGTON CO. BIRMINGHAM 1878

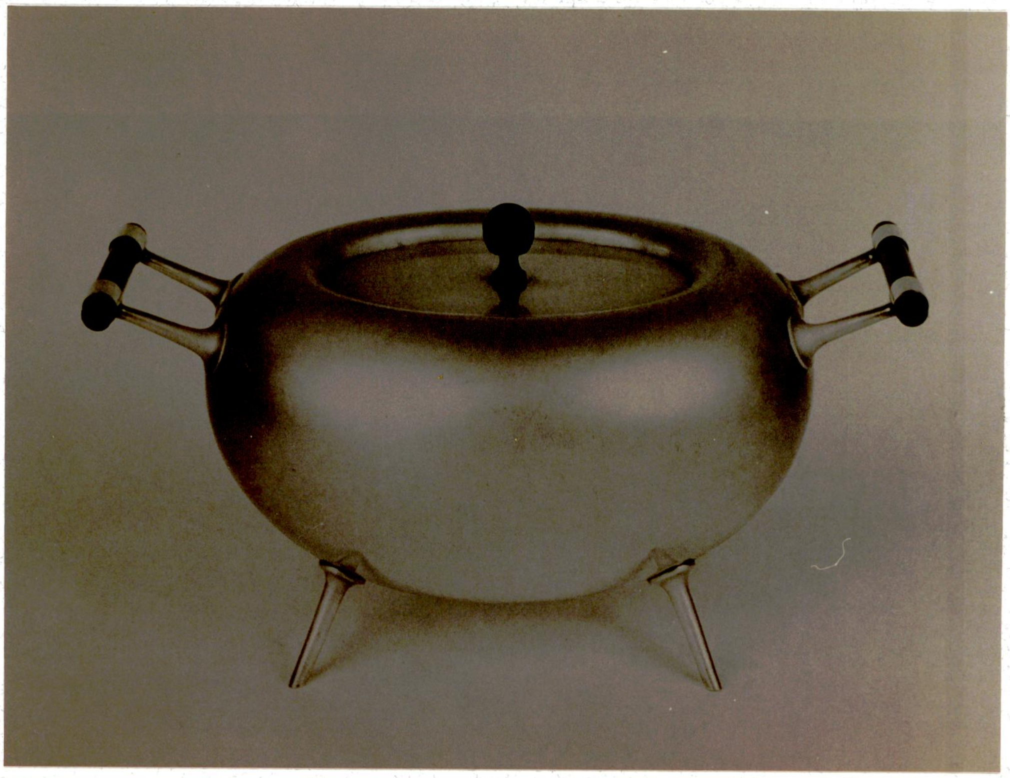

Fig. 6 DRESSER, C. TUREEN
THE ELKINGTON CO. BIRMINGHAM 1869

In his design for an electroplated decanter (Fig. 7), produced by Hukin and Heath of London in 1878, Dresser combines metal with glass to create an object which :

> In its revolutionary simplicity occupies a place apart from contemporary work, including the bulk of Dresser's own work. In it we find none of the bristling contours of contemporary applied art nor the "horror vacui". Instead form and function have fused in a unity which may with good reason be admired by a child of the twentieth century. (Madsen, 1975, p. 151)

Like the sugar bowl in 1865, Dresser bestows the decanter with three legs, giving stability without excess weight or bulk. The 'foot-like' terminations enchance the feeling of organic vitality and life, but these legs are not crouched, they stand proudly upright supporting the glass amphora with the dignity and elegance associated with wine drinking. The amphora seems to hang like a ripe fruit, bursting with intoxicating flavour. The handle curves vigorously upwards to join the neck which erupts from the body of the vessel.

> We feel the impression of great power which he strove to convey and for which he found his inspiration in "luxuriant tropical vegetation, the spring growth, and in certain bones of birds which are associated with flight and strength "? (Madsen, 1975, p. 152).

Concerning the function of the decanter, Dresser says :

> As most decanters are intended to hold wine, the brilliance of which is not readily apparent when that portion of the vessel which contains the liquid rests immediately on the table, it is desirable to give the vessel a foot, or in other words, raise the body of the decanter so that light may surround it as fully as possible. (Dresser 1870, p. 26)

Dresser successfully satisfies this requirement and makes an aesthetic complement to the function through the forms he uses. 'Aesthetics and 'Utility' are united harmoniously, giving power and integrity to Dresser's design.

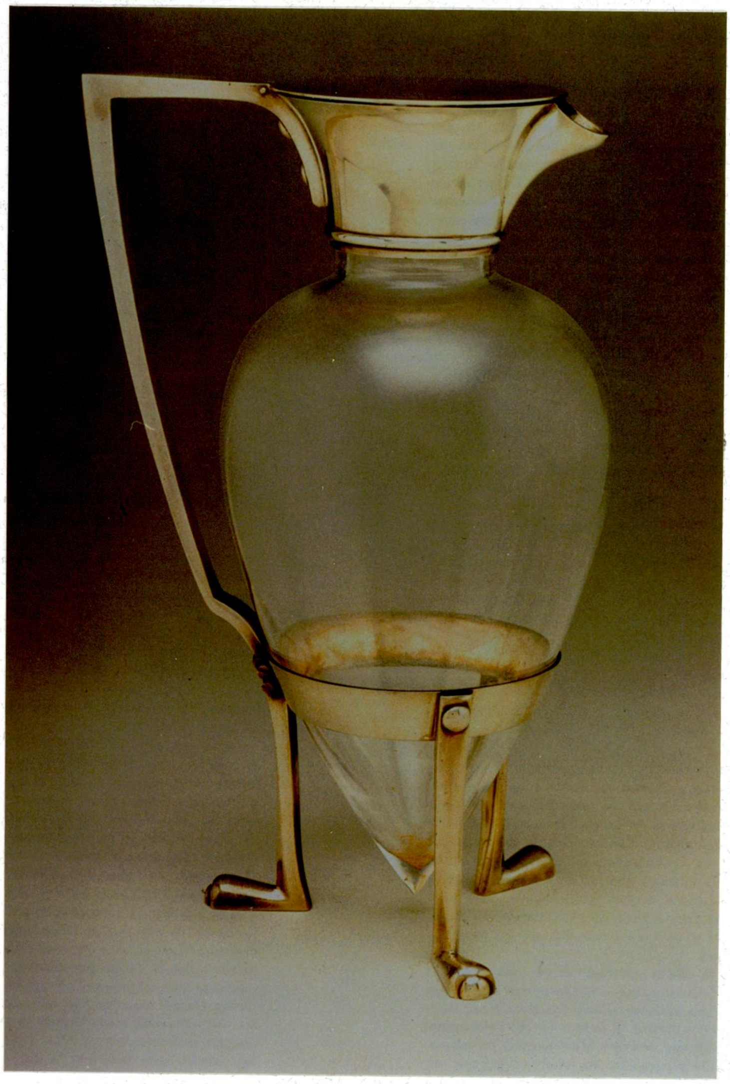

Fig. 7 DRESSER C. DECANTER

HUKIN AND HEATH LONDON 1878

During the 1880s Dresser made a number of designs for glassware, most of which were produced by James Couper and Sons of Glasgow. The designs were known as 'Clutha' glass.

Dresser believed that cut-glass violated the molten nature of glass, he stressed the use of appropriate manufacturing methods which took advantage of the natural properties of the material.

> It will be found that whenever the true susceptibilities of a material are sought out, and the endeavour is to produce beauty by the mode of working which is most benefitting to the peculiar mode in which the material is worked, that the manufacture progresses in art. (Dresser, 1862 (4), p. 117)

Dresser maintained that few materials lent themselves more readily to this purpose than glass and clay. He stressed the similarity between the glass blowers rotating of the pipe and the potters work at the wheel. Both methods involved the application of natural laws and brought about shapes that were beautiful, simple and functional.

> Glass has a molten condition as well as a solid state, and while in the molten condition it can be blown into forms of exquisite beauty ..... for the operation of gravitation and similar forces upon plastic matter is calculated to give beauty of form. (Dresser, 1873, p 24)

Dresser's inspiration from nature is obvious in his design for 'Clutha' glassware.

> Frequently characterised by attenuated necks with burled or wavy rims, Dresser's vases have been compared to his dissections of flowers, and clearly some of the shapes owe much to his artistic botany. (Halen, 1990, p. 193)

In (Fig. 8) and (Fig. 9) a selection of 'Clutha' glassware is shown, produced by James Couper and Sons between 1880 and 1883.

Both the shape and colour of the vase (Fig. 8a) are reminiscent of a daffodil ; the flared, wavy brim, and the crooked neck drooping like a soft, fragile flower. Another vase (Fig. 9a) stands straight and tall like a 'vigorous tropical plant' its wide neck poised as if to catch the 'monsoon' rain water.

The decorative streaks of colour applied to many of these pieces are applied as the piece is being shaped, giving visual clues as to how the piece was manufactured, like growing lines, marking areas of expansion and constriction.

As the glass blower works, the piece tends to grow in all directions, it is by restricting this growth that the craftsman moulds the piece into the desired form, similar to the way the natural environment acts on a growing plant.

In 1879 Dresser helped establish the Linthorpe Art Pottery in Middlesborough. Dresser had become friends with John Harrison, the owner of the Sun Brick Works on the Linthorpe estate. Dresser suggested that the brick clay could be more profitably adapted to pottery production. Harrison agreed and the Linthorpe Art Pottery was founded, with Dresser as chief designer.

For a short period between 1879 and 1882 Dresser made a number of highly successful designs which were produced in large numbers by the Linthorpe pottery.

> The essence of Dresser's Linthorpe potters lay in its rich glazes, and its almost sculptural quality, which reveals his skill in creating shapes. (Halen 1990, p. 139)

Fig. 8 DRESSER, C. CLUTHA GLASS
JAMES COUPER 6 SONS GLASGOW 1883

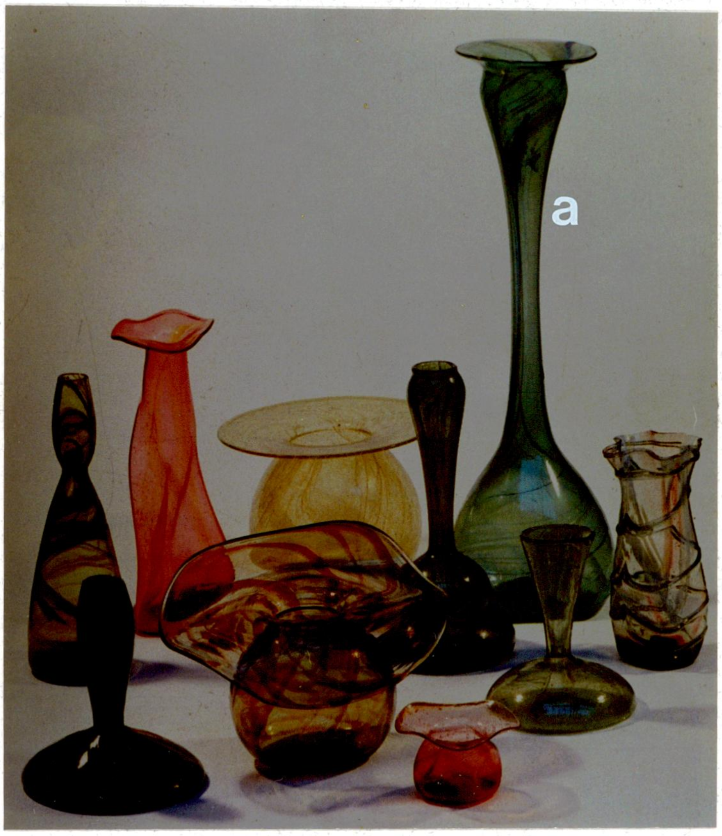

Fig. 9 DRESSER, C. CLUTHA GLASS
JAMES COUPER & SONS GLASGOW 1880

Although Japanese ceramics were a big influence for Dresser's Linthorpe pottery, the forms and colours in many of these designs are reminiscent of natural plant forms. One particular vase (Fig. 10a) uses a form for the base of the vessel which could be derived from the seed head of a sprouting flower.

The dynamic twisting of another vase (Fig. 10b), reminds us of some tropical vegetable as it grows out of the ground. Another piece (Fig. 11a) uses colouring which could be compared to that found in exotic plants and fruits, a rich, ripe red blends into a strong dark green of growth.

Fig. 10 DRESSER, C. POTTERY
LINTHORPE ART POTTERY MIDDLESBOROUGH 1880 - 1882

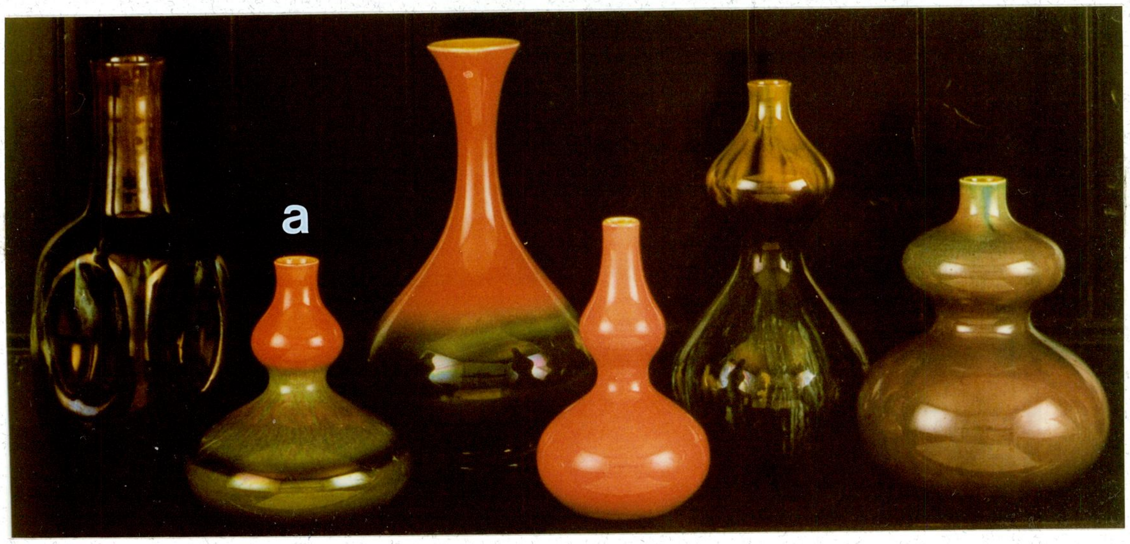

Fig. 11 DRESSER, C. POTTERY
LINTHORPE ART POTTERY MIDDLESBOROUGH 1879 - 1880

In all the works discussed, Dresser's inspiration is taken from the forms of nature he studied as a botanist.

His use of conventionalised plant forms give his designs, through psychological association, a feeling of dynamism, efficiency and integrity, or in his own words, 'Truth, Beauty and Power'.

He borrows the complex curves and flowing lines of nature and uses them in sometimes abstract ways which retain the energy and vitality of their inspiration. These characteristics of Dresser's work show his use of the 'Bio-aesthetic' approach derived from the evolutionary analogy.

Dresser also proposed theories which were derived from the ecological analogy and anticipated Papanek's 'Function Complex'.

He stressed the appropriate use of materials and that the natural properties of a material should be used to create forms efficiently and easily. The use of clay on the potter's wheel and the methods of glass blowing are processes which Dresser admired for their use of the inherent properties of the material.

He also advocated 'honesty to construction' which gives integrity and coherence to a design, like the integrity and coherence in the 'correlation of parts' seen in natural organisms. This approach is similar to Papanek's definition of 'good method'.

Dresser claims that 'utility must precede beauty'. This is his ranking of priorities of 'use' and 'aesthetics' in the 'Function Complex'. But it is in the areas of 'aesthetics' and 'association' which Dresser makes most use of organic analogy and it is in these areas that the analogy is most successful, giving the striking dynamic appearance which overflows with energy and vitality.

CHAPTER V CONCLUSION

In Chapter Two of this thesis, 'design' was defined through Papanek's 'Function Complex'. This definition shows how design is affected by its context and requirements. A basis is laid for the analysis of designs and the approaches which generated them.

In Chapter Three the term 'Organic Design' is defined and put into the context of this thesis. The various 'organic' analogies are discussed and an evaluation made of their success and usefulness to the designer. It is found that only two of the analogies are successful and useful.

These are, firstly, the 'Ecological' theory that 'forms are defined by the functions which are defined by the environment'. This is a restatement of Papanek's 'Function Complex'.

The second successful theory is the 'Bio-aesthetic' approach which takes inspirations from the forms of nature and uses them in 'aesthetic' and 'associational' ways, giving energy, vitality and life to a design.

In Chapter Four the work of Dr. Christopher Dresser is taken as an early example of the application of organic analogy and particularly the theory of 'Bio-aesthetics'.

Dresser uses the flowing curves of nature in an almost abstract way, transforming his botanical models into their 'conventionalised' forms. These simplified, idealised plant forms bring about psychological associations in a more subtle and subconscious way than the direct representation of the 'Arts and Crafts' movement. Dresser's designs evoke feelings of energy, vitality, life, growth and health, they are dynamic without being chaotic or confused as the 'Art Nouveau' style can sometimes be.

Dresser would have agreed with Papanek's definition of 'Good Method'. He stressed that materials should be used appropriately and that they should not attempt to be what they are not. He placed great emphasis on simplicity, and 'honesty to construction' which would give integrity and coherence to a design, like the 'correlation of parts in an organism'.

Dresser's successful use of the organic analogy shows in his theoretical approach, the priorities he gives to 'utility', 'beauty', and 'honesty', which are based on the 'Form/Functions/Environment' theory. He successfully uses psychological association with organic form and creates abstract aesthetic beauty through the use of curved, flowing lines and simple, geometric forms.

The scientific approach of Dresser's 'Truth' is embodied in the 'Form/Functions/Environment' theory, which results in the same principle as Papanek's 'Function Complex'.

Dresser's use of the 'Bio-aesthetic' approach gives a 'beauty' to his designs which evokes feelings of growth, strength, vitality and natural energy.

Perhaps the 'Bio-aesthetic' approach is the most 'pure' of the organic analogies. Its results cannot be achieved in any other way for it is only through the 'association' with a living organism that a lifeless artifact can acquire an image of natural growth, vitality and living energy.

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