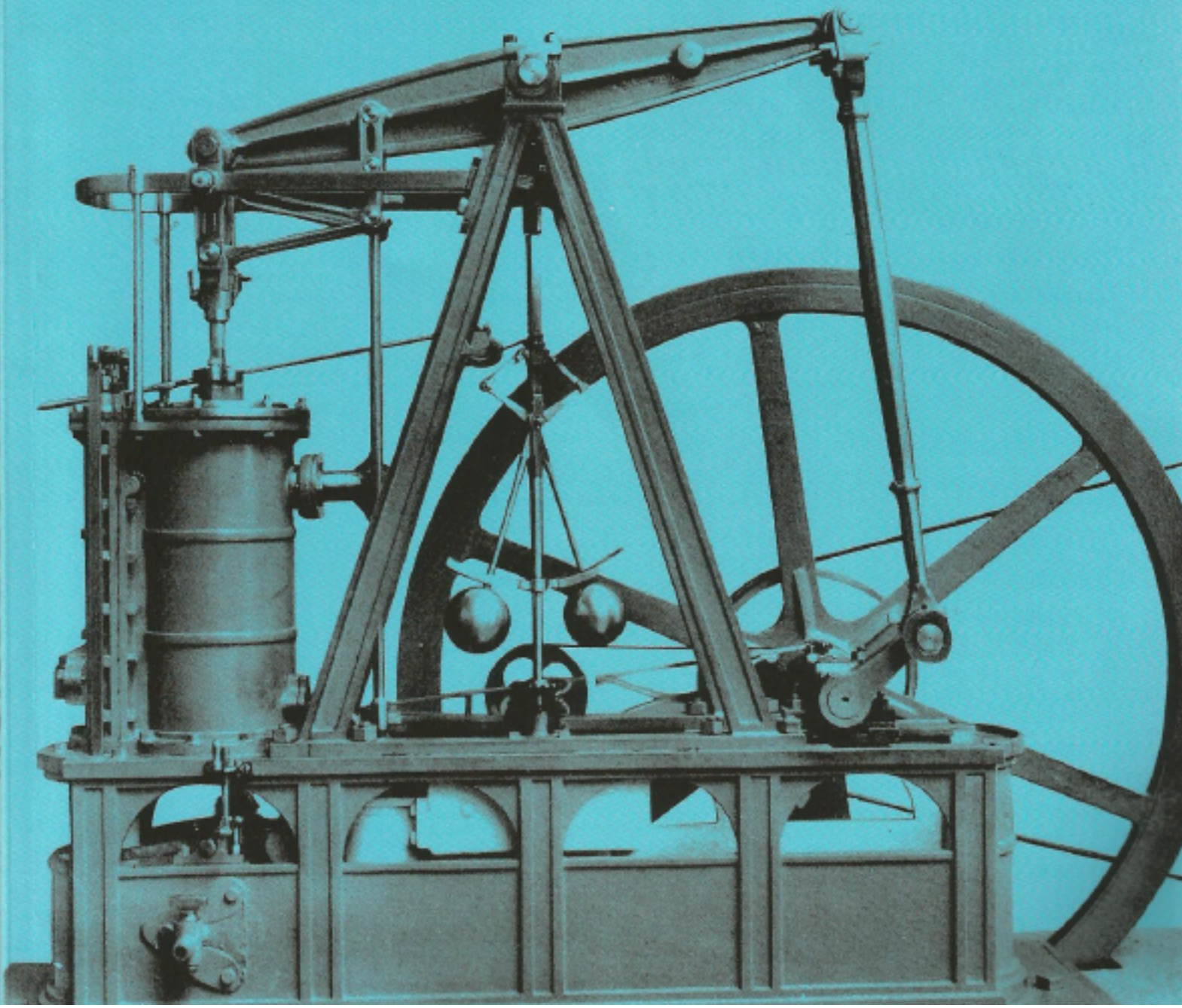
David Pye

THE NATURE & AESTHETICS OF DESIGN



First published as *the Nature of Design* in 1964.

This edition first published in 1978 by
The Herbert Press
an imprint of A&C Black
38 Soho Square
London W1D 3HB
www.acblack.com

First published in paperback 1982.
Reprinted 1988, 1995, 2000, 2007

ISBN 978 0 7136 5286 4

A CIP record for this title is available from the British Library.

Printed in the United Kingdom by Lightning Source UK Ltd.

6. Invention: analogous results

The poet invents new juxtapositions of words and phrases which convey a new experience. The inventor makes new juxtapositions of things which give new results. Neither the poet's words nor the inventor's things have any remarkable properties of their own. They are everyday words and things. It is the juxtaposition of them which is new.

Before anything is made, a desirable result is likely to have been envisaged. The man who envisages the result may already know of a system or several systems which are capable of giving rise to it, and in that case no further invention is needed. If you say, 'Invent me something which will result in these books and this alarm clock remaining at rest at this level which I will indicate on the wall', I shall at once think of a shelf on brackets, which I remember to have seen giving the same sort of result with the same sort of things before. I shall not be hailed as a great inventor. I have simply had to determine the class to which the specified result belongs and to consider which devices of all those in my memory give rise to results of the same class. But have I really done even that? I doubt it. I have simply envisaged the books up there on the wall, compared the vision with various sights stored in my memory, found one which showed books half way up a wall, noticed that there was a shelf under the books, and concluded that a bookshelf would do now because it was suitable before.

That can be a bad procedure. There may be other systems which are better than the first which turns up in the memory.

The author once set about designing a draining rack. It was for the plates, pot-lids and so forth used by his family while living in a tent. It had therefore to be very small and very light. Because he started by thinking 'I must design a draining rack' instead of considering what kind of result was wanted, his train of thought was conditioned unprofitably. Racks act by supporting. Any instance of a rack which will support plates must have dimensions comformable with those of the plates, and there is a limit below which its size and therefore its weight cannot be reduced.

After prolonged thought the designer realised his mistake and started to consider what result he wanted, namely, a row of plastic plates edge-on in mid air. He then started to search his memory for results of the

same class but not necessarily involving similar objects or, at any rate, objects which were closely similar. Doing this is not as easy as it sounds. Because it was not easy his mind ran to a result involving objects which, if not closely similar, at any rate were suggested by a very obvious association, namely a row of cups hanging on hooks. The unconscious association must have been plates – saucers: saucers – cups. Thus the thought of plates unearthed the memory of cups.

It was then easy to arrive at the required invention, a thin stick carrying a row of thin wire hooks like cup-hooks; for the desired result was by now well in mind, and the objects in it too, the flexible rather soft plastic plates, which being rather soft at once suggested that holes might be cut in their rims.[2]

Designers and their clients seldom formulate their purposes in terms of the desired results, but on the contrary habitually do so in terms of the systems of things which give rise to them. As the example of the dish rack showed, this may be a bad habit; but it will only be bad if some new factor in the situation, such as plates made out of easily drilled plastic, is overlooked. Otherwise the designer's normal habit is mere common sense. If you want to enable someone to sit, it will be idiotic to proceed in the way that students of design are sometimes advised to do, and think out the whole problem from first principles, as though all the people who for the last four thousand years have been making and using chairs were half-wits. Where the problem is old, the old solutions will nearly always be best (unless a new technique has been introduced) because it is inconceivable that all the designers of ten or twenty generations will have been fools.

When a desirable result is envisaged and the memory, being searched, shows no immediate picture like the bookshelf, then the same procedure must be followed as was done with the dish rack. A similar result involving different objects must be sought, in the hope that the device which gave rise to it can be adapted to the objects which are now intended, or that these can be adapted to the device. It is here that our habit of refusing even to name results, and our habit of referring to them by way of mythical actions, and all the habits of mind associated with them and with the idea of 'function', all these help to make our task more

2. In case anyone wants to adopt this important invention let him be warned that in a breeze of wind it makes a noise like a muffled glockenspiel. Take it down at night.

difficult and to inhibit us from discerning analogies between different results; for we are averse from thinking of classes of results, as such, in any case, and have no proper tools to do the thinking with. Invention can only be done deliberately if the inventor can discern similarities between the particular result which he is envisaging and some other actual result which he has seen and stored in his memory (which must of course be well stored so as to give him a wide choice and therefore a better chance). The fact that we habitually visualise particular results is something of a stumbling block too, in its way. We *envisage* or feel the desired result. We see it or feel it, objects and all. Our memories are visual or muscular memories of particular results, not conceptual memories of classes of results. We see or feel in our memories particular results each including a particular system with its particular components and above all with the particular objects which were involved. Out of that lot we have to abstract the class of result, averting our attention from the particular system and objects. This is not easy when one is reviewing the bloodless ghosts of memory.

If an exact classification of devices were made according to a close analysis of the characteristics of their results it would presumably be possible for computers to invent, provided that their memories were full-fed. For all I know they are doing it now. But it may be doubted whether the classification could be subtle enough or the feeding full enough to enable them to spot far-fetched similarities with the same genius which human inventors have sometimes shown. What association gave Watt his centrifugal governor? A merry-go-round? Who is going to feed a computer with merry-go-rounds?

An inventor's power to invent depends on his ability to see analogies between results and, secondarily, on his ability to see them between devices – a thing which is very much easier to do, for the visible schema of a device is the essential principle of arrangement; and we are fairly well habituated to recognising similarities between devices by means of that. It is indeed our normal means of doing so. An example of analogising was quoted in connection with the design of the lever in Chapter 4. When the designer had his brain-storm he saw an analogy with the yuloh which was the

antecedent of his doubled lever. He was looking for a combination of results – the fulcrum steadied, the stone abutted to a block on the lever, the lever stiffened at the fulcrum. The association by which the antecedent was fetched up from the memory was partly visual; the yuloh has a step in it, and a lever with a step in it suited the second result of the three desired. But the association was partly by feel, I believe. I had imagined the feel of the lever working, and had once done the same for the yuloh.

It is unfortunately impossible now to discover what trains of thought did in fact lead to the invention of most of our devices, but it is easy to construct hypothetical trains of thought showing the analogies by which they might have been arrived at. For example, we may suppose that a clasp knife was invented in a desire to make a knife short enough to put in one's pocket. A sheath knife was too long. 'How', the inventor asked himself, 'can it be made shorter? How do you make things shorter? What results are shortened results? A telescoped result and a folded result come to mind: Like my footrule'. Here he has found a fruitful analogy, for he envisages a knife folded, handle to blade, like a foot-rule; and the picture in his mind's eye shows him the edge of the blade guarded by the handle – an extra advantage thrown in for nothing. The invention has been made. It remains to improve it by adding a system to keep the knife shut or open.

Such an example may suggest how the process of deliberate invention works. But there is something between deliberate and accidental invention. This takes place when the purpose, the desired result, is inchoate or unconscious. We may suppose that the inventor of the typewriter watched a pianist playing very quickly and thought 'How quickly the notes follow one another. I can scarcely distinguish them. C – B flat – A, could it have been? Letters. If only one could write so fast. Each key writes a letter as you press it. Press. Printing press. Press the key and the little oblong hammer hits the string. Presses the string down. Presses the letter. The letter is printed on the paper.' There he has the typewriter, each hammer in the action of the piano printing its own letter. He saw the analogy between the two results, a sounded letter and a printed letter.[3]

A desired result is not always envisaged before an

3. Some slight colour is given to this story by the fact that early typewriters had piano keys.

invention is made. More commonly perhaps an accident will produce a result which is only then seen to be desirable. Whatever a designer's purpose may be, he ought always to watch for accidental variations of things designed and take advantage of them in the way of appearance or use, if their results suggest anything to him. Many, if not all, scientific discoveries are made by a kind of inspiration fastening on an accident.

The authors of most of the inventions based on accidents are forgotten. There can be little doubt that most of the cardinal inventions were made thus, before history; but there have been recent examples. A circular saw can be used to cut a groove in wood, the groove being as wide as the saw is thick (or a little over, the teeth being set). The saw fits the groove. Some sawyer or millwright made a mistake when he fixed his saw on its spindle. The spindle ought to have been at right angles to the face of the saw, but it was not quite at right angles. He noticed that the groove it cut was slightly over size. This must often have happened. But someone instead of correcting the error was inspired to increase it so that the saw visibly wobbled – in which condition it is called a wobble-saw or drunk-saw – and by this means he made a thin saw cut wide grooves. The width of the groove cut by a drunk-saw is twice the amplitude of the wobble, and it is a most unlikely looking tool, but an effective one.

To take advantage of such a chance occurrence is a considerable creative feat. These things always seem so obvious after the event. An inventor who does this is able to do it because he is able to see not only the particular (and annoying) result under his nose but also the whole class of results which it typifies; and further, because he can envisage the other results of that class in all sorts of different chains of results. He is obviously more likely to make the invention, the discovery, if he has already envisaged such a class of results and desired it before the accident occurs. His mind will then be prepared.

As we have already remarked, there is no essential difference between invention and scientific discovery, for both are the disclosing of a fact about the natural behaviour of things or of combinations of things. Pasteur speaking of scientific discovery said that 'Chance favours the prepared mind.'[4] A classic instance of this was seen

4. Quoted by W.I.Beveridge in *The Art of Scientific Investigation.*

in Fleming's discovery of penicillin. He did not discover penicillin. The action of moulds on bacteria had been observed and reported before he also chanced to observe it. But he had a prepared mind in that he had already envisaged an antiseptic which would be carried in the blood stream, a desirable result never yet attained and one which, to judge from his profession's lack of interest, was very unlikely to be attained. But he believed in its possibility and thought that in the result of penicillin's action on bacteria he perhaps saw a means to that end – as in fact he did. The remarkable part of his achievement was his vision of the end result and persistent search for it. There can be little doubt that most apparently impossible results have been envisaged only after a chance discovery has strongly suggested them and not, as with Fleming, before some apparently trivial accident has led a man of vision to them.

The two commonest sources of chance discovery or invention are play and error. In play one may fiddle about with things aimlessly – or without conscious aim – and suddenly discover an unexpected result, much as one solved the wire puzzles in Christmas crackers by fiddling with them. We shall never know how many of the primary inventions are due to children's play.

In finding by error one may put together a known system in the wrong way, as with the drunk-saw, or make components of the wrong shape through inadequate technique and find that the system gives rise to an unexpected result of which advantage can be taken. If you are bad at building skin boats you may make one unusually box-like and find it unusually stable. You may make another one unusually fine and pointed, and find it unusually fast. And so on.

The man with a vision of some desirable result may deliberately court chance occurrences by experimenting with one thing after another almost at random, as Ehrlich did before he discovered Salvarsan, and Goodyear before he at last discovered how to vulcanise rubber.

We see, then, that finding always precedes design. The finding process may be extremely simple. There is nothing in finding the appropriate system for supporting books against a wall, or for protecting feet. The finding becomes inventive when analogising is involved or that vision which prompts us to take advantage of accidental occurrences. Design as distinct from invention is

prescribing a particular instance of the system which has been found, in order to accommodate given objects and a given prime mover; or the combining with this of palliative and other devices. But they also have to be found and their finding may be inventive. Deliberate invention as distinct from design is the finding of a system or a complex of them which will give rise to a desired result, the system or something analogous to it being previously known to the inventor but not previously associated with the particular objects in the desired result (as for example in the case of the dish rack quoted above).

It is certainly very near the truth to say, that if you cannot find any analogy at all with your desired result, then you cannot invent deliberately. If you desire the result of a sky-hook or any other for which no system is known and no analogy can be found, then you can only prepare your mind and wait for something to turn up. And after all, nearly every device we have has grown out of primary discoveries which simply turned up. One might even differentiate invention and discovery by confining the term 'discovery' to inventions arising from chance occurrences not deliberately courted.

There seems no reason, on first consideration, why a system of forces should not first be invented by reasoning from known principles of mechanics, and then clothed in things. But this does not happen. Why should it not? Let us try it. Of all desirable inventions a sky-hook is the most desirable. It would simplify technology quite noticeably. Let us first invent a complete system of forces for a sky-hook and then clothe it in things, and make our fortunes. The problem is to invent it, not design it. A helicopter is a sky-hook of a sort, but somewhat unhandy in the home. We are to invent a sky-hook. The question arises, 'What exactly do we mean by a sky-hook system?' Well, what do we mean? When we know what *things* we mean by a sky-hook system, then, and not before, we shall be in a position to describe the system of forces. Invention must come first.

You cannot proceed by saying, 'Here is the result, thing suspended in mid-air; let us think out how to produce it', unless you make some assumption about what it is suspended from or propped up by. If your

assumption proves good, you have made an invention. If you already know that it is practicable you are using an invention which has already been made.

If there had been no inventions there would be no theory of mechanics. Invention came first.

Theory is an aid to variation of inventions, that is to say, to design. A designer who understands the essential principle of arrangement and the response, will be able to reason about his trial variations. This one has the right arrangement but the desired change is not taking place; why? That one has the wrong arrangement, therefore the desired change can never take place and it must be abandoned. But theory is not an aid to invention as such, except in so far as it enriches an inventor's feel for his job, and no one knows how far that can be. Indeed no one knows whether after all a knowledge of theory actually inhibits an inventor's creativity. In time we shall find out. Our entire theoretical knowledge has been founded on abstractions taken from the fruits of inventions made without theory. Whether theory is a vivifying essence which will enliven our inventive faculties, remains to be seen. It is becoming a commonplace that scientific discovery is an art not a science, being a matter of chance favouring the prepared mind; but we do not yet know whether the mind is prepared or stultified by loading the memory with theory. Presumably some minds will be helped by it and some not. We may be improving our powers of design at the expense of our powers of invention. Moreover it is arguable that we have inventions enough already.

Anyone with experience of training designers will confirm that a man who is capable of invention as an artist is commonly capable also of useful invention. Leonardo's exceptional genius in both useful and artistic invention seems to have fostered the idea that he was exceptional also in combining these two talents; but this is not so. The combination is usual rather than exceptional, so usual in fact that one is led to suspect that both are really different expressions of one potentiality.