CREATIVE PROBLEM SOLVING, SYSTEMATIC DESIGNING AND PROJECT MANAGEMENT

"We are all continually faced with a series of great opportunities, brilliantly disguised as insoluble problems".
"... reality is itself a combination of determinisms, and freedom consists in overcoming and transcending these determinisms"

Jacques Ellul 1964

How do traditional designers cope with complexity?

In what ways are modern design problems more complicated than traditional ones?

What are the interpersonal obstacles to solving modern design problems?

Why are the new kinds of complexity outside the scope of the traditional design process?

· Amateur/Professional
· Traditional/Modern
· Foretell the Future
· The "vegetable Soup"

What is the essence of 'designing'?

- Finding the right physical components of a physical structure.
- A goal-directed problem-solving activity
- Decision making, in the face uncertainty with high penalties for error
- Simulating what we want to make, or do, before eve make, or do, it as many times as may be necessary to feel confident in the final result.
- The conditioning factor for those parts of the product which come into contact with people.
- Relating product, with situation to give satisfaction.
- The performing of a very complicated act of faith.
- The imaginative jump from present facts to future possibilities.
- A creative activity - it involves bringing into being something new and useful that has not existed previously

TRADITIONAL METHODS

Craft process can produce a beautiful and complicated object (Gothic Cathedrals).

Organic look of plants, animals and nationally evolved forms. Beautifully organised complexity of Farm Wagon, Rowing Boat, Violin and Axe can be done without trained designers, managers, salesmen, production engineers and other specialists.

Hidden in the apparent simplicity of primitive craftwork is a subtle and reliable information transmission system comparing in many ways with the Redesign methods.

Checklist to identify Craft processes

1. Craftsmen do not - often cannot, draw their works and neither can they give adequate reasons for the decisions they take.

2. Craft product form is modified by countless failures and successes in a process of trial and error over (cf. this is a slow and costly sequential 'design' process which produces, in the end, therefore, in our terms, expensively) an astonishingly well balanced result.

3. Craft evolution can also produce discordant features. The kink/waist in a 4 wheel wagon - an attempt to reduce turning circle u ' non change from 2 wheel to 4 wheel in the late 18 Century, not able to accommodate more than one change without a complete reorganisation.

4. Cumulative "store" (of concept development) is firstly the product itself which is not changed save to meet new demands, or to correct errors, Fragmentary information is stored as patterns (profiles, jigs etc) and also as exact memories of the actions needed to recreate the traditional shape of the product. These could be said to provide the 'genetic coding' upon which craft evolution depends,

5. The two classes of data important to contemporary design, the shape as a whole and the reasons for the shape are not recorded, and therefore cannot be investigated and altered without experiments. Such experiments involve the loss of patiently won balance and fit of an earlier design, and can only be attempted when new demands cannot' be met by gradual evolution.

Design by Drawing

The act of concentrating the geometric aspects of manufacture into a drawing.

1. Specifying dimensions in advance of manufacture makes it possible to split up the production work to be made by different people. This division of labour is the strength and weakness of industrial (Production line) industrial society.

2. Scale is the major benefit advantage of making things that are too big for a single craftsman only interfaces are fixed by pattern to which each man works. One can regard such drawings as a coming together of the isolated parts that were originally recorded as patterns and "rules of thumb".

3. Not only size but rate of production: here is concomitant division of labour entails loss of quality that still makes us think of proper craft products as belonging to the "good old days".

Thus "designing" came into being. The designer can see and manipulate the design as a whole. Almost alone the 'holistic "cooks"' of modern industry, as opposed to 'atomists'.

A designers starting point is often a single design which he can visualise fairly precisely in his mind's eye. His main criterion, when comparing one to another is the geometrical consistency of carts -tested by drawing. Design by drawing can be seen as an accelerated version of craft evolution, with freedom to change several parts at once, rather than one at a time.

Compatibility of designed object to situation. "Designer" design is weaker than "craftsman" design; this is overcome to some extent by making models or prototypes which can be seen and tested. Early stage scale drawings done by one person only. Only when critical sub-problems are solved can the work be split up between others, This is a limitation of being only able to use a single mind at the most critical stage of designing.

How do we cope with complexity?

Scale of drawing approach - greater 'perceptual span' than available to craftsman. If designer is dealing with 10 part product - 10 ways each can be designed: total number 10^{10} (ten billion). If (s)he uses a drawing to select 10 parts geometrically compatible. Task is choosing is then 10 times between 10 sub solutions (100).

When considering external - as opposed to internal - compatibility- no help from drawing. We rely on experience and imagination and this (drawing) does not say a lot about this mysterious -and essential aspect of designing. "Inspirational" designing characteristically involves':

1. Long periods of seeming inactivity - only take in information - work rather fruitlessly at trivial aspects, give attention to unrelated matters. This is 'incubation',

2. Solution of a difficult problem, the occurrence of an original idea will often come all of a sudden (leap of insight) and can take the form of a dramatic change in the way the problem is perceived (change of set). This can turn a complex problem to a simple one.

3. The enemies of originality are mental rigidity and wishful thinking - either acting in a far more regular way than the situation demands - or being inescapable of perceiving (or considering to contemplate) the external realities that make his ideas unworkable.

The "traditional" way is to operate - at any one time- only upon a single conception of the whole. In traditional design methods the complexities of designing are dealt with by using a tentative solution as a rapid exploration of the situation and of the components of the design.

NEED FOR NEW METHODS

Why do we need to innovate the system?

External Complexities

1. Technology transfer. Search for technology developments and inventions capable of solving local design problems - eg. plastics in furniture.
2. Prediction of side effects - testing consumer/public opinion early enough to effect change in design.
3. Standards of compatibility - national, corporate or international TV standards, plugs, safety regulations, corporate identity.
4. Sensitivity to human overlap - plastic chair (minute projections snag nylons). Chair designers and stocking designers thus interact - number of overlaps is enormous.
5. The impossibility of removing major incompatibilities between products unless the emerging system is reorganised and the products radically transformed to make possible a different allocation of functions.

Internal Complexities

1. Increasing high investment needed to achieve economies. This change increases the penalties of design error to where design has to be right first time and where trial and error is out of the question.

2. The difficulty of applying information from outside sources to an existing situation – without upsetting internal parts. Compatibility already achieved, Structural engineer may strengthen moulding unaware of balance between shape and moulding speed achieved by production engineer.

3. Difficulty of discovering rational design sequences when influx of new needs, new materials, new technologies or new ideas are continually upsetting the relationships between design variables.

PEOPLE/GROUPS INVOLVED IN DESIGN PROCESS

Organisations through which a new product passes in the course of its life history.

1 . Sponsors - The client, likely to have a narrow and financial interest. Team likely to have a limited brief if they respond with a wider devised one to achieve a gross, rather than marginal improvement. This could involve radical new product. Sponsors are likely to feel no immediate linking for the new baby and fail to recognise it as part of their future.

2. Design Team - If integrated and united in the common interest of a single employer - it may be able to cope with drastic transformations. If boundaries shift, the team will have to represent professions or connect whit professions not hitherto obliged to collaborate.

3. Suppliers - Suppliers of materials and sub-components may well over-estimate their ability to meet new product demands. They are free of vested interest in shape being concerned only with size and regularity of orders, Early contact whit suppliers can counteract the many other stimuli that will resist change in the status quo.

4. Producers - Product engineers can tend towards ant change view. It is very difficult to predict with any accuracy the cost of design changes before the detailed manufacturing specification has been worked out, there is a need to project to examine scenarios in the future.

5. Distributors - Distributions channels are the most stable element of the whole picture - and the most expensive to create or alter and react directly to customer demand, or perceived customer demand.

6. Purchasers - Sometimes same as users, sometimes different odds are against radical design because operational features have to be taken on trust - and the purchasers need to collect a product that symbolises a picture of himself that he wants other people to recognise. Customer is highly sensitive to minor changes in style, colour or pattern but may well be indifferent to wholly new shapes that have not yet acquired a recognised meaning or social significance. These differences of sensitivity are good reasons for not basing new designs upon results of preference research.

7. Users - Take a long time to adapt to design change and are unpredictable. It is true to say they will adapt (against their long term interests) to things for which the cost of adaptation is high but delayed. Those designers dealing with similar questions must sometimes disregard user opinion and act upon the results of observation of behaviour and moral and economic assessments of costs and benefits.

8. System Operators - People concerned are not trained or accustomed to assess the effects of any but minor changes upon themselves and upon their organisations. Critical case of a newly emerging product, or system. Existing parties will only partially see the merits or demerits of the new system.

9. Society - Political action and public protest are often the only channels for effecting the more important aspects of social-technical change. Only through the exercise of political and economic pressure that the need for large scale changes in the system can be expressed.

SYSTEMATIC DESIGN

A product designer must be:

- Multi-skilled
- Fanatically -'customer-oriented' - playing the role of the consumer
- Deeply committed to systematic design methods
- Knowledgeable about a wide range of manufacturing business
- Comfortable in marketing, design and engineering disciplines
- Accomplished and skilled in creative problem solving

Ground-rules for Systematic Design:

This is far too important a task to be left to clairvoyance or happenstance and must, therefore, be tackled systematically. Setting clear and realistic targets for a new product provides the vision of what that product must achieve to be successful. The most important targets are those demanded or wished for by customers. Other important targets include compatibility with the skills and facilities of the manufacturer, suitability for the intended marketing, sales and distribution channels and conformance with relevant statutory or industry standards. Designers who fail to set targets will fail to see what they must achieve in order for the new product to succeed.

It is one of the most widely held myths that the use of systematic design methods strikes that creativity dumb. Nothing could be further from the truth. Creativity, as Thomas Edison once said, is 1% inspiration and 99% perspiration. The preparation arises in preparing your mind - building the foundations upon which the building blocks of creativity are set. The historical accounts of truly great discoveries tend to focus on the final leap of intuition which made the breakthrough. Little mention is made of the months solutions and exploring all the ideas which eventually proved useless. In many of these cases it as the articulation of incorrect solutions which led, step by painful step, to the breakthrough.

If it takes ten ideas to come up with one successful product, creativity must be given the freedom to come up with unsuccessful ideas in order to discover the successful ones. *Indeed, the number and quality of the ideas which are rejected is probably the best measure of a person's idea-generating capabilities.* When someone has a single idea and proceeds on the basis of that idea, it might be a good idea but, equally it might be mediocre - or even completely useless. When someone has selected the best of 10 ideas, the chances are much greater that this idea will be good. Taken to its logical extreme, the closer you get to thinking up every possible solution to a problem, the closer you will be to finding the best possible solution. Freedom to express creative ideas, including those which ultimately prove worthless, is, therefore, a virtue in new product development. Since it is difficult enough, to come up with a single solution to most problems, the prospect of having to generate many solutions is formidable.

Creative thinking in practice

The practicalities of creative thinking have been written about extensively. In fact, so much has been written on the subject that it is difficult to see the wood for the trees; there are creative thinking techniques, variations on those techniques and variations on the variations. From all that, has been written, however, several key issues emerge.

Preparation

Design problems are usually complex, in as much as they have several goals, many constraints and even greater number of possible solutions. In designing a new product, you will be trying to satisfy the needs of a wide range of customers, exploit to the full the abilities of sales, marketing and distribution channels, fit in with existing manufacturing facilities and suppliers and end up making a profit for the company. Defining a design problem to take account of all of this takes a lot of preparation. Often there are no learning problems to overcome but reluctance to resort to methods of mental trickery may well make these methods unusable. *It takes an effort to recognise a blocked state of mind and to deliberately change strategy.*

Exploring, expanding and defining a problem seeks answers to several questions.
- Exactly what problem is it that you are trying to solve?
- Why is it a problem?
- Is it a part of a bigger or more general problem?
- Would solving this more general problem also solve the immediate problem?
- Is, therefore the immediate problem the best problem to be tackling?
- What is the ideal solution to the problem?
- What is it about this solution that makes it ideal?
- Is this solution ideal only in particular circumstances and if so, what are these circumstances?

These overall considerations concerning the design may conveniently be broken up into three major areas:

Analysis, synthesis and evaluation:

breaking the problem into pieces
\+ putting the pieces together in a new way
\+ testing to discover the consequences of putting the new arrangement into practice.

STATING OBJECTIVES

1. Identify the situation within which the design is to operate,
2. Identify features of the situation with which the design must be compatible if it is to be accepted by the sponsors.
   2.1 The sponsor's expectations and the reasons for them.
   2.2 Identify the resources available.
   2.3 Identify the essential objectives (those that, if not satisfied, invalidate the project).
3. Ensure that statements of essential objectives are compatible with each other, and with information that becomes available.

NB

a. Objectives are stated as precisely - or as roughly - as available knowledge permits.
b. Objectives are revised as information gained during designing is shown to strengthen or weaken the assumptions.
c. All sub-objectives are stated and shown to be necessary to the achievement of the ultimate objective,

Stating objectives is particularly important in situations where neither the sponsors, not the designers have experience of the kind of thing that is being designed.

IDEA CREATION; REMOVING MENTAL BLOCKS

. Transformation rules that can be applied to an existing unsatisfactory solution, or part of it.
. Searching for new relationships between parts of an existing unsatisfactory solution.
. Reassessment of the design solution.

Divergence

Extending the boundary of a design situation so as to have a wide enough and fruitful enough search space in which to seek a solution. Some characteristics of this include:

1. The objectives are unstable and tentative.
2. The problem boundary can be unstable and undefined.
3. Evaluation is deferred, nothing is disregarded if it seems relevant to the problem, although it may conflict with everything else.
4. The brief is treated as a starting point only, and is expected to be revised, or evolved (with the sponsor's agreement).
5. The aim is to deliberately increase uncertainty, to clear away preconceived solutions, and to reprogram the brain with a mass of information thought to be relevant.
6. To test the sensitivity at this stage of such important elements as sponsors, users, markets, producers etc to the consequences of shifting the objectives and problem boundaries.

It may be useful to think of divergent search as being a testing for stability, or instability, in everything connected with the problem. Stable and unstable points are just as likely to be discovered at a low level of product or component, as at a high level of collective goals and personal value judgements. The aim of the designer is to avoid imposing a premature pattern upon what they discover (first answer). These are skills which come more readily to scientific research, essay writing and statistical analysis. Designers have quite a lot of unlearning to do

before they can maintain the detachment, flexibility and breadth of view that is appropriate before design decisions are taken and before it is wise to get involved in anything approaching a solution.

In short, it can be said that the aim of divergent search is to de-structure, or to destroy, the original brief while identifying these features of the design situation that will permit a valuable and feasible degree of change. To search divergently is also to provide, as cheaply and quickly as possible, sufficient new experience to counteract any false assumptions that the design team members, and the sponsors, held at the start.

BRAINSTORMING

- Select a group: the more *active* brains, the better.
- Enforce the role that no idea is to be criticised. Wild ideas are welcome, quantity is wanted and participants should combine, or improve upon, ideas suggested by others.
- Record the ideas. Evaluate them afterwards.
- Use cards or tablecloth. Cards, Post-it notes subsequently easier to tabulate.
- Argued that this process raises quality a well as quantity.
- State idea simply and directly.
- Use either at start, or when sub problem arises.
- Can also be used to generate information, sources, questions for a questionnaire.
- Easy to do at first attempt. Brainstorming only requires that members have a fund of relevant
- experience that is ready to be tapped
- 6 people can product 150 ideas in about half an hour.

(Examples)
- Raise £1000 for department student funds.
- Improve relationship with workshops.
- Future of domestic telephone or television.

Bug list

Let me give you an example of the use of lists as thinking (rather than memory) aids. Make a "bug list".
People with a healthy fantasy life often play with the concept of inventing something with world needs and retiring on the proceeds. However, relatively few of them accomplish this. There are two factors which explain this lack of follow-through. The first is the difficulty in thinking of something *specific* that the world *needs*. The second is that it may require many years of concentration, apprehension, financial deprivation, and floundering family life before an invention can be made to pay off. The second factor is the more serious obstacle to this type of retirement. However, since it is not important unless the first hurdle can be cleared, and since we have no solutions here to the second aspect, let us pursue the first further. In order to think of a potentially successful invention, it is necessary to establish a *specific need*.

A problem which most people must cope with here is a tendency to generalise. If one of your needs is to eliminate air pollution or eliminate violence, you are setting yourself a tall task. The best way of starting on your retirement is probably to come up with a list of specific-small-scale needs.

A "bug list" is such a list.

If properly done, your bug list should spark ideas in your mind for Inventions. The list should ensure that specific areas of need are illuminated and that you have put in a reasonable amount of fluency and flexibility of thought. It should contain far-out bugs as well as common ones. For many of you, it may be the most specific thinking you have ever done about precisely what small details in life bother you.

After students make such lists, they can be asked to turn them into inventions. Almost invariably, an interesting "invention" - innovative design - results.

Clichés and proverbs

An 'interesting way to jolt conventional thinking out of a rut is to use clichés and proverbs. The idea here is that most of these common sayings have sufficient generality to be relevant in just about any situation. Armed with a list such as the one provided below a problem can be explored by taking one interesting or relevant saving and examining how it might apply to the problem.

Most familiar

- Practice makes perfect
- Better late than never
- If at first you don't succeed, try, try, try again
- Like father like son
- A place for everything and everything in its place
- Two wrongs do not make a right
- Two's company, three's a crowd
- Where there's a will there's a way
- Don't count you chickens before they are hatched
- Easier said than done
- All's well that ends well
- Practice what you preach
- You can't tell a book by its cover
- An apple a day keeps the doctor away
- A penny saved is a penny earned
- Cleanliness is next to godliness
- Mind your own business
- Beggars can't be choosers
- Easy come easy go
- Beauty is only skin deep
- Beauty Is in the eye of the beholder
- You can't teach an old dog new tricks
- Better safe than sorry
- Two heads are better than one
- Actions speak louder than words

Most 'visual'

- When the cat's away the mice will play
- The early bird catches the worm
- Like father like son
- Kill two birds with one stone
- Don't count your chickens before they are hatched
- If the shoe fits wear it
- Monkey see, monkey do
- A man's home is his castle
- The bigger they are the harder they fall
- Birds of a feather clock together
- Two's company, three's a crowd
- You can lead a horse to water but you can't make it drink
- Don't cry over spilt milk
- Two heads are better than one
- We're all in the same boat
- Never bite off more than you can chew
- One bad apple spoils the barrel
- Put on your thinking cap
- You can't teach an old dog new tricks
- You can't tell a book by its cover
- When it rains it pours
- Don't rock the boat
- Too many cooks spoil the broth
- Look before you leap
- A penny saved is a penny earned

The above selection was found to be the top 25 sayings out of a list of over 200 presented to US undergraduate students. The column on the left gives the sayings that were judged most familiar. Those on the right were judged to evoke most visual images.

SWOT analysis

SWOT stands for *strengths, weaknesses, opportunities and threats*. SWOT analysis provides a simple but systematic framework for appraising the company's or problem's current position status under these headings. Strengths and weaknesses are current factors and are mostly internal to the situation. Opportunities and threats are anticipated future issues and are mostly external to the company. There are four stages in SWOT analysis:

Firstly, brainstorming gets down on paper a long list of first thoughts, under the four headings. Many people get put off by this first stage of SWOT analysis because many issues can be categorised under all four headings. For example, the fact that customers like our latest product and are buying it faster than we ever thought possible would seem, at first glance, to be an important strength. It could, however, be seen as a weakness that his product is now contributing such a large percentage of turnover it is an opportunity to build upon this success with future products. But it is also a threat that company growth from this product may not be sustainable. Do not worry too much about this. Write as much down as you can think of and sort it out in the next stage.

Stage two clusters similar or related issues together. This stage can be made a lot easier if you have written the initial SWOT issues on Post-it notes.

Stage three analyses the issues, generalises them into broader strengths, weaknesses, opportunities and threats and prioritises them.

The final stage synthesis the information gathered, identifies the main issues that require changes to be made and makes decisions about how to introduce these changes. If SWOT analysis is being conducted as part of a more extensive planning process, this final stage can be deferred until any other relevant information has been gathered and analysed.

Analysis is more robust and more realistic if completed by several people, preferably with different job functions and different responsibilities.

The key to effective SWOT analysis is realism and honesty.

PEST analysis

PEST stands for *political, economic, social and technological* features of the business environment which might influence or even threaten the company. The acronym PEST suggests that these are all nuisance or hindrance factors to design development. New regulations to be complied with, increased taxes or import tariffs, reductions in market size due to demographic changes or the threat of new technology rendering products obsolete - these are all the stuff of executive nightmares.
Often, however, PEST factors can often be of considerable business value. Deregulation is opening up many previously inaccessible markets, innovation awards or business development loans can make unaffordable development work possible. Changing trends in consumer awareness and purchasing habits can revitalise stagnant market sectors. And new technology can help you to leapfrog your competitors, provided you get to it before they do!

This technique is, in truth, little more than four headings to stimulate thinking about broad aspects of the business environment that might otherwise go unnoticed.

Political - Changes in law or regulations introduced by Governments or government agencies. Can also include political changes which may stabilise or de-stabilise national markets for products.

Economic - Macro-economic issues can have a strong influence on business, these include national economic growth or recession, exchange rates, stock market fluctuations and changes in national, regional or local fiscal policy. Economic issues of more immediate significance include bank lending rates, the availability of grants, awards, subsidies or unsecured loans and trends in economic indicators such as salary levels or raw material prices.

Social - Demographic trends include changes in the population age structure, trends towards a multi-racial, multi-cultural society and increasing levels of education. Social awareness of environmental issues has had a profound effect on purchasing habits in many market sectors.

Technological.- New technologies, material and production freedoms.

SCAMPER

SCAMPER is an acronym and stands for 'substitute, combine, adapt, magnify or minify, put to other uses, eliminate or elaborate and rearrange or reverse'. Together, these headings make up a checklist of possible product modifications for stimulating ideas. When thinking about possible product modifications it is all too easy to concentrate only on the obvious ones and overlook others. So, for example, when trying to make a product less expensive to manufacture it is likely that you would think of making it smaller, eliminating some of its features or substituting expensive materials with cheaper ones. It may, however, be easy to overlook the possibility of rearranging the components to reduce assembly times or even making it bigger to relax manufacturing tolerances. The use of a checklist forces you to go through all the possible modifications to the product which might solve the problem.

Put to other uses?
New ways to use as it? Other uses if modified?

Adapt?
What else is like this? What other idea does this suggest? Does past offer a parallel? What could I copy? Whom could I emulate?

Modify?
New twist? Change meaning, colour, motion, sound, odour, form shape? Other changes?

Magnify?
What to add? More time? Greater frequency? Stronger? Higher? Longer? Thicker? Extra value? Plus ingredient? Duplicate? Multiply? Exaggerate?

Minify?
What to subtract? Smaller? Condensed? Miniature? Lower? Shorter? Lighter? Streamline? Split up? Understate?

Substitute?
Who else instead? What else instead? Other ingredient? Other material? Other process? Other power? Other place? Other approach? Other tone of voice?

Rearrange?
Interchange components? Other pattern? Other layout? Other sequence? Transpose cause and effect? Change pace? Change schedule?

Reverse?
Transpose positive and negative? How about opposites? Turn It backward? Turn it upside down? Reverse roles? Change shoes? Turn tables? Turn other cheek?

Combine?
How about a blend, an alloy, an assortment, an ensemble? Combine units? Combine purposes? Combine appeals? Combine ideas?

Be warned, using product modification checklists can be a mind-numbing experience, especially with complex or multiple component products. But if it helps solve the problem, the gain is worth the pain. It might also save a lot of frustration and wasted time in the long run.

Thesaurus

applied to existing unsatisfactory solution - or part of it

1. Roget Thesaurus abstract terms grouped under existence, relation, quantity, order, number, time, change and causation
2. Searching for new relationships between parts of an existing unsatisfactory solution. Forced relationships - juxtapose each part of an ensemble in pairs

3. Reassessment of design solution. The why, why, why? method

Analogies

An analogy is a particular form of thinking or reasoning in which the properties of one object are thought of in terms of a second object which is different but has certain properties in common. So, a length of rope could be thought of as a rattlesnake when it is coiled up on the floor or as an escape chute when suspended from an upstairs window or a gripping hand when tied tightly round a bundle of sticks. There are several ways in which analogies can be used in creative thinking. They can be used simply to change your perspective on a problem and to 'free up' your thinking. More specifically, they can be used to explore new functions, new features and new applications for a product. If a piece of rope is like an escape chute when it is suspected from an upstairs window, how could we improve the piece of rope to make it a better escape chute. Escape chutes are generally smooth and certainly do not burn your hands when you slide down them. They often have a steep slope at the top but then run out gently at the bottom to slow you down before you reach the ground. Is there any way a rope could be designed with these properties to make it function better for escape. Finally, they can be used to create completely new solutions to problems by discovering how the problem is solved or partially solved in a totally different context. The ski jump inspiring the take-off platform of an aircraft carrier is an example.

When using analogies try to stick to the following rules:

. Think of the essence of the problem in abstract terms. A can opener 'removes' part of a can, a cup is a container', a belt 'grips' or 'squeezes' the object it is tied around. Use this abstract description to stimulate analogies.

· Find analogies which have an element of action or movement associated with them. Biological analogies such as the rattlesnake or gripping hand above are usually good in this respect.

· Do not force the analogy to fit the problem too quickly. Take your time and think in simple steps. Generate a list of analogies without thinking about the problem. Then write down a list of associations for each analogy. Again withhold judgement about their relevance to the problem. Now try to force a fit between each association and the problem to be solved.

Analogies into Synetics (THINK TANK)

· Group of highly selected people to act as independent development department.
· Lot of practice in the use of analogies to relate the spontaneous activity of the brain and nervous system ---> problem.
· Submit difficult problems that parent organisation can't solve and allow plenty of time for solving.
· Submit output to present organisation for evaluation and implementation.
· About 6 outsiders and insiders. different professions, flexibility of thinking, range of knowledge, experience, and for contrasting personality types select by observation of conversational behaviour, bodily movement and ability to participate with existing synetics groups. The new group is provided with separate premises, funds and a workshop in which they can test their own prototypes.
· *Direct* analogies. Readily found by seeking a biological solution to similar problem. Eg. Brunel shipworm/caisson. Howden's Chunnel machine/worm
· *Personal* analogies. What would "it feel like to be....., what forces, what would it "feel like" to be a VCR, a bed, a FAX machine.
· *Symbolic* analogies. These are poetic metaphors and similes - mouth of a river, head of a hammer, tree of decisions, damp an oscillation.
· *Fantasy* analogies. What if, if only, to improve things as they are known not to be. "Slave" to dial for us. Road that disappears except where wheels touch ground ("caterpillar" tracks").

Direct - Worldly
Fantasy - Unworldly
Personal - Bodily

Symbolic - Abstract

A. Problem is given (PAG)

B . Purge of obvious solutions. Clearing away solutions which are likely to be permutations of existing.

C. Make the strange familiar ("what you need here is an anti-gravity machine"). Analogies are sought which will transform the 'problem as given' into terms that are familiar to the experience of the members.

D. Problem as understood (PAU). The crucial difficulties and conflicts that prevent a solution are defined.

E. Evocative questions. Chairman asks for a solution in terms of the types of analogy. The group plays with each evocative questions. If the analogies get too abstract the discussion is redirected towards the problem 'as understood'. When a promising idea appears it is developed verbally to a point where rough prototypes can be made and tested. Members get very elated when a solution is achieved and afterwards appear to be physically exhausted.

Obstacles include:

* Rigidity of thought

* Delays that prevent innovation proceeding at pace of thinking and consequently inhibit it altogether

* Lack of time for uninterrupted thought and discussion

* Inability to stimulate spontaneous thinking on problems for which there is no conventional solution

* Guilt at being paid for such an enjoyable activity

* Over-confidence after solving one's first problem in this way

Synetics appears to suit the middle stages of designing the examination of a problem previously shown to be real and the production of a solution that others will implement,

Synetics is intended to throw up a general solution to a problem - just as a screw thread is a general solution to the problem of fastening.

Learning Synetic thinking activity
Difficult to do. 6 months-1 year training, Most withdraw after a few years of synecting (?) - cumulative stress to the nervous system. Success may not come easily, and there is a risk to mental health.

TRANSFORMATION

Stage of pattern-making, fun, high level creativity, flashes of insight, changes of set, inspired guesswork - everything that makes designing a delight. It Is also the stage when big mistakes can be make, when wishful thinking or narrow mindedness can prevail. Care must be taken not to saddle the world with expensive, useless, harmful results of large but misguided investments of human effort. There is not way of being sure that what is being done will, in the end, be "best".

1 . The main objective is to impose a pattern that is precise enough to permit convergence towards the single design which must be decided upon and fixed in every detail. In this context pattern-making is the creative act of turning a complicated problem into a simple one by changing its form and by deciding what to emphasise and what to overlook (PDS).

2. This is the stage when objectives, brief and boundaries are fixed, when critical variables are identified, where constraints are recognise when opportunities are taken and judgements are made.

3. The stage when the problem is split into sub-problems each of which is judged to be capable of solution in series, or in parallel, and in relative isolation.

4. The personal aspect of designing is most evident at this stage. In general, the stronger one's grasp of the world, existing and potential, the more intolerant one will be of any transformation other than the one you perceive to be correct. This is where Design by Prima Donna can go wrong.

PRODUCT FUNCTION ANALYSIS

This is a method of systematically analysing the functions performed by a product (as perceived by the user). Also known as FAST analysis (Function Analysis Systematic Technique), it is the most basic and probably the most important analytical technique in new product development. All you need for product function analysis is to know how the product will operate in use. You must know, or be able to predict, the functions of the product as perceived by the customer and how the customer rates the relative importance of these functions. It can be applied both to existing products and to those still being designed. Product function analysis provides a detailed understanding of the product from a functional and customer-orientated point of view and presents this understanding in a logical and systematic framework. Its results can be used to stimulate concept generation.

Product function analysis procedure.

The first step in product function analysis Is to brainstorm all the functions the product will serve in the eyes of the customer. The best approach is to write down on individual scraps of paper (Post-it notes are ideal) every single function that you believe your product will perform. This means asking what the product 'does' rather than what the product 'is' - which is how engineers often think. Do this from a customer point of view but make sure that you write down all the functions that the customer values. Do not take any functions for granted (eg. It is obviously important that a vacuum cleaner has wheels and is able to move across the carpet but customers might take this for granted). Try to keep the descriptions of function to two or three work 'verb-noun' combinations (eg. contain fluid, break circuit, expel moisture, provide visual indication). Keep brainstorming until you feel you have exhausted all the product functions: most products will have at least 40-60 functions and only the simplest products will have fewer than 20.

Next arrange these functions into a 'function tree'. To start the function tree, select the prime function of the product. This is the main reason that the product exists in the eyes of the customer. The prime function of a vacuum cleaner, for example, is to 'remove debris', not to 'suck air'. Once the prime function has been selected, the other functions are grouped logically and hierarchically under it.

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