TEACHING DESIGN - A THOUGHT FOR THE DAY

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Design - synthesis by definition and creative in action, is a mould that shapes the future. With limited resources and evergrowing needs, our standard of living tommorrow, largely depends upon how our design engineers are trained today. The uplift of the society comes from the practice of design as an art & science of systematically creating products or services to meet the needs. Thus the key to national progress lies in quality of design teaching.

Design And Its Importance

The word 'design' needs careful understanding. As it is commonly used, it would seem to imply, the final product to be created, but that is production. Although design and production are both creative activities, they are different. Design is a process of arriving at a detailed description of a new product to be created. Production is a physical creation of the product based on the design description. Production always follows design. In situations where a new article is straightway created, the substantial part of the design activity takes place in the creator's mental faculty and generally goes on till the article takes shape. In such cases design without appearing in black and white, leads to production.

Design is a difficult word to define, so let us try to comprehend it first. Design is an art of systematically creating a new object or a new service to meet a need. It is an activity of predicting, modelling, analysing, synthesising, evaluating and improving until the description of the product, that meets the purpose, is chalked out. To design a new artifact, one can use existing objects and/or concepts and put them together innovatively to achieve the purpose. Alternatively, one may create new objects and/or concepts and put them together. More likely, particularly when the need is new and complex, one combines some existing and some innovative objects or concepts. In general, a new idea is used along with many known and existing ones to produce a new product of value. In this activity observation, logic, intuition, curiosity, memory and instinct play their role.

In our description of design, we have used many key words, that give us a feel for the activity, what we call design. Now let us look for a sharp and crisp definition. Some good examples are : "It is an activity of production of final description of the artifact

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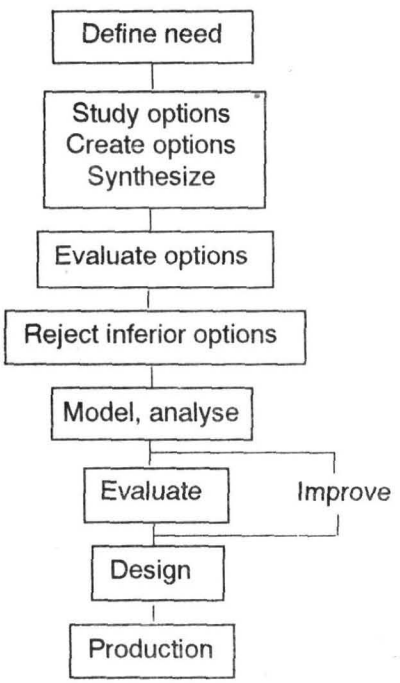
" - Nigel Cross; " To work-out the structure or form of something by making a sketch or plans; Intended plan for a purpose " - Collins; " Conscious effort to improve meaningful order" - Papner; " It starts with the definition of a system for a purpose and proceeds to analyse the system down to a level such that all documentation exists for the complete creation of the system " - Miles. According to Prof A K Rao at Indian Institute of Science- "Design is an art of solving real problems with natural constraints and built-in uncertainties", Essentially, in engineering sense,"Design is an employment of art and science, with some creativity and originality, to generate a description of an artifact that meets a well-defined need, safely, economically and aesthetically". With this understanding of the design process, we can schematise its morphology as in fig 1.



Importance of a good design activity comes directly from the changing needs and desires of our society. Today, society primarily needs prosperity through creation of goods and services. An engineer alone cannot fulfil all the needs of the society but he plays an important role in bringing about these through desing of required artifacts or services or systems. Society imagines. Designers convert this imagination into reality in today's world, society needs assistance - mechanised or automated. Designers lead to production of such assisting systems. Infact design and production are two legs on which the society progresses. The dependence of our society on the systems and services created by our design engineers is increasing day by day. Thus society needs good designers and in substantial strength (numbers).

Are we (teachers) training our students to create and design?

Teaching Design

No, doubt, it is a difficult task to teach design as an art and science, but it is not impossible. Today, in majority of the undergraduate engineering colleges, where a engineering student is supposed to build his foundations, the design course is handled like any other engineering subject. As a consequence, the engineer appreciates the art involved in designing only when he gets to know about it, after a few years in proffession, which is generally too late for him to develop it to himself. Perhaps design teaching needs a different approach or style.

The concept of design as it is being taught today is -" A process of sequentially solving a few equations and applying formulae to arrive at preliminary details of an object which already exists". It is not being taught as a process of creating new

objects.Creativity or synthesis is not at all being emphasised. Initially it is good to teach design of nuts, bolts and shafts etc. but in subsequent courses, the student must be trained on real problems. creativity and real design of nuts, bolts and shafts real problems. Creativity and real design problems are the two key issues which need far more emphasis than anything else while teaching design.

Why real design problems ?

There is a famous chinese proverb which says that a hungry man's immediate need may be fish but his virtual long term independence comes only if he is taught fishing. In the present teaching, the widely practiced tendency is to transmit information (give fish). When a student goes into profession, standard nuts and bolts are available and his job is far more challenging than he is trained for. He goes berserk. So what he actually needs is an art to handle practical difficulties never faced before (fishing). That is where the need for real-problem handling technique is felt.

Talking books can not teach design

The importance of teaching design on real problem comes from the fact that the actual process of design has a large number of aspects linked to it. Some of them are decision making with lack of information, uncertainly and probability, possibility of non-unique solutions and solution procedures, constraints and limitations, feasibility and acceptability, time and cost, coupling with other problems, and so on. The actual design process involves a lot of predicting, modelling and evaluation and all the time working with little information. Designers have to be optimistic and yet realistic. Thus a good design teaching would consist of a process by which a student gets the feel for some of these intricacies involved in the design activity rather than the associated mathematics and logic. Should'nt we train our students on real problems ?

We are not short of real problems. Industry has plenty of them. Undergraduate students can be trained on practical problems faced by them. In the process, the industry will get cheaper brain- power and the financial assistance will be a sufficient motivation for the students to actually get involved, putting in the required extra effort and thus develop this applied art, which comes mainly through practice.

Shouldn't we collaborate with industry for mutual benefit ?

Creativity :

Creativity-the origination of a concept, usually in response to a human need, is a solution that is both satisfying and innovative. Any original procedure to solve a problem is a creative process. Till some time ago, it was believed that creativity is a 'divine- gift' to a few fortunate people. Presently the belief is that all persons of normal intelligence possess creative ability, children being the most creative. Social environment, home life and educational experiences either stimulate or depress the urge to be creative. Ross Money has quoted.

"We do not have to teach people to be creative; we just have to quit interfering with their being creative" Conforming to group standards and thwarting or suppressing the individuality of thought changes a students personality and over a period of time he loses his originality. So what is important is to allow the student to think free - without the fear of being wrong and encourage him to generate ideas that may appear vague, as even one good idea out of fifty will pay for the time and

effort over the rest of the fortynine stupid ideas. An excellent example is that during early days of space research, probably the most laughed at idea was' put a rocket over another to reach greater heights'. Today, it is called 'multistaging', and is the most important feature of almost all launch vehicles. Thanks to the people who took the idea seriously.

Another way of developing creative design is to develop the habit of asking questions. 'Reason can answer question, but imagination has to ask them.' An enquiring and a questioning mind contributes considerably towards a creative design. It is comparatively easier to design if a person can set out without preconceived notions and is able to enquire and question. The success in building a flying machine eluded the society of people thought that nature is always the best and so the flying machine must have flapping wings. This notion was shed when somebody argued 'why should nature be the best, if that were so the train should have legs' and then came the fixed wing aircraft from Wright Brothers. We must understand that questions are not foolish and no man becomes a fool until he has stopped asking questions.

Are we training our students to be inquisitive ?

Every idea is a product of a single brain. Just as soon as a student gets an idea, he is a minority of one. In this situation, may be, the correct way is to give support to the idea and change the minority to majority and then investigate the feasibility. But the present tendency is to compel such a student to forget his idea and go along with the thoughts of the majority of the class and that is what kills his creativity.

"Conformity in behaviour is a human neccessity

Conformity in patterns of thought is a human danger"

--- J H McPherson

Are we facing this danger ?

To cover up our inability to teach 'real and creative' design, we generally plead" our education system is like that, there is no provisions for such methodologies in our curriculum, University wants this, ... and so on." The question that comes up then is, "Should we continue to teach like this within the existing framework of the system ? or should we change the curriculum so that the teaching produces valuable graduates ? An example that can fit well here is" should we tailor the trouser to suit the legs or should we tailor the legs to suit a short trouser and get handicapped for ever ?"

Role of Computers

CAD, a word very commonly used today, is grossly misleading the undergraduate community which does not understand what real design is and what is the role of computers in designing. Computer aided design (CAD) is a design in which computer's assistance (aid) is taken during a part of the work. It does not imply that computer is used to create the design of the artifact. Design is a creative process and the computers today are not creative. In the entire process of design, computer is just an efficient tool to handle mathematics or to study simulation models. The feeling that the computer can do the job of a designer is wrong. It can only go through a process or a sequence of instructions as modelled by the designer and will give no information about the applicability or reliability of the model. Human element is unavoidable in modelling,

evaluation, judgement and decision making.

Moreover, the CAD packages are for standard design processes hardly involving any innovation and are aimed to equip the technician with the mathematical and logical capabilities of a designer. A design engineer today is to be trained, not with a view that he will use the CAD like a technician but with an objective that he is going to develop CAD that others, who are not trained in design, can use.

Are we doing this ?

Computer should be conceived only as an analysis tool in the synthesis - analysis - synthesis design loop. It is a faithful and an efficient servant trained to handle limited mathematics and logic. Even in analysis, the computer is limited to a given set of instructions and any deviation from that leads to wrong results. Recently when the American aerospace engineers wanted to rebuild the Wright Brothers aircraft, for FAA certification, all the required stress and strength calculations had to be done manually. Even on supercomputer, they could not compute the airloads and stress data using the best of their CFD (Computational Fluid Dynamics) and FEA (Finite Element Analysis) packages as the softwares were not modelled to handle a low speed biplane aircraft with crosswires and struts. So powerful the digital computer is, yet so severe are its limitations that until a designer understands his place in the CAD process he can not harness all the potentials of the man-machine combination for design. Human brain is still the most important element in the design activity with potentials far more than a computer and the computer is the most important tool in the design process with high speed analytical capabilities, as instruted by the human element. No machinery exists today with human ability for judgement and opinion.

We conclude : Design, being a creative activity, is not definitive. Thus the teaching of design is different than any other subject.

Can we train a design student to be creative and capable of confidently handling real problems ? I think ..... we can.

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