

Engineering Design

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The Place of Engineering Design

The profession of engineering is distinguished from its close relatives by a single feature. Its close relatives are the descriptive and analytical sciences on the one hand, and the aesthetic arts on the other. The distinguishing feature of professional engineering is its complete dependence on functional design. Naturally, this engineering design is most often based on the descriptive/analytical sciences and will also include elements of the aesthetic, but it is primarily functional.

Design Aspects

Engineering design, as defined above, will therefore have at least three aspects: functionality, anti-failure and (to a lesser extent) aesthetic appeal. Functionality requirements ensure that the (necessarily manufactured) device/system fulfils some specific purpose. Anti-failure or integrity ensures that numerous (sometimes extraneous) conditions, loads and abuse do not disrupt the functionality of the device. Aesthetic requirements will not be discussed here except to suggest that where these dominate, then perhaps the process is not engineering design.

Design is Fundamental

Because the activity of design is so fundamental to engineering, it permeates every aspect of the profession. Thus, it is quite common to hear that engineers cannot discuss a problem without talking about it in terms of solutions to the problem. Even the discipline of "engineering science" is taught and understood as solutions to design problems (as it should!) Thus, it is very difficult to separate the practice of design from "the rest of engineering." Despite this, anecdotal evidence suggests that only about one third of the profession is directly involved in design; the remainder occupy themselves with management (where the "serious" money is), maintenance, research and education etc. However, all activities in engineering ultimately support the design effort - else there would be no professional engineering.

Design Classification

As commonly practised, engineering design could be loosely classified as follows:

- Design by code - where conservative rules of thumb predominate
- Design by analysis - where fundamental engineering science predominates

Most engineering design is a mixture of both these types. However, the primary justification for professional engineering education design training is to prepare practitioners to intelligently override or contravene code rules, when appropriate, without endangering the product's functionality or integrity.

Optimal Design

Obviously, several engineering design solutions will usually be possible for a given problem. The universal measure of the quality of engineering design is the cost of the solution (assuming all other requirements are met.) which will be capital and/or recurrent cost. There has now developed an ethical issue surrounding the actual cost vs the total cost including environmental and societal factors, which, for cultural and historical reasons are often omitted or ignored. The current trend toward including such costs in the actual (lifetime) costing is to be applauded.

Relevance of Design and Design Committees

While general design principles, valid for all engineering disciplines, can be enunciated, few designers who work in one field can move to another. Indeed, this is another ethical tenet espoused by the Institution of Engineers, Australia, that engineers should not work outside their field of expertise. For this reason a general engineering design committee/society cannot hope to have wide appeal unless it caters to the specific needs of various industry practise groups. However, it can promote design within one branch of engineering and help celebrate the discipline for the profession as a whole.

Conclusion

Design is integral and fundamental to the practise and profession of engineering. Thus, any activity which promotes design, by either instruction or celebration, can only benefit the profession. A national committee on engineering design (or similar) under the auspices of the IEAust is an appropriate vehicle to further such ends. The attached suggests some mechanisms by which this might be achieved.

Activities to Promote the Awareness and Practise of Engineering Design:

- Hold regular technical seminars on design (The Waves conference was an example of this.)

- Find and disseminate books and literature on design (eg French M J, 1988, Invention and Evolution: Design in Nature and Engineering, Cambridge University Press, Cambridge, etc.)
- Maintain liaison with other design committees such as those of SAA which are devoted to design (eg ME/1/3 on pressure vessels, etc.)
- Hold events to encourage and celebrate engineering design (eg, Warman Prize.) Perhaps a (irregularly held) prize could be offered in recognition of excellent design (as opposed to a project.) [Note: This is a delicate issue because what is now recognised as engineering excellence is most often a direct result of the discipline of design.]
- Maintain a watching brief on the appropriateness of the design content of engineering syllabus in teaching institutions.
- Develop criteria for above.
- Investigate the best techniques for teaching and learning design (assuming that is possible) in both Engineering courses and in the work-force.
- Disseminate this information to practitioners of design rather just the teaching institutions.
- Develop high school kits to encourage young potential designers to choose engineering design and the professional satisfaction and intellectual challenge it offers as a career.

Loss of Design

There has been two noticeable trends in engineering:

- Discourage the practise and discipline of design by rewarding people more who abandon it
- The inexorable demand by nervous managers discourages innovative design which means that more and more engineering is a repeat of previous accomplishments.

It cannot be stated too strongly that engineering is inseparable from its design function. What now passes as engineering is little more than the equivalent of domestic house construction where engineering input is almost never required. Thus, if design and innovation are discouraged, much of the challenge and satisfaction will disappear from engineering.

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 February 2000