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Consumer concerns relating to durability, reliability, and serviceability

The concepts of durability, reliability, serviceability, and maintainability are not new to those engineers or businessmen who have been involved in the design and assembly of products since the current technical era began. In the early days of the development of mechanical devices such as the steam engine, automobile, steam heating systems, and air conditioning apparatus and machinery, the primary emphasis was on successful development of a workable machine. Many of the machines from that era are still operational even though technological development has rendered them obsolete. The competitive pressures that existed at that stage of development were overcome by the inventor who developed a better machine. As we pass from the embryo stage in any field of technology into its mature phase, the apparatus or systems that have been developed create a mushrooming market whose need manufacturers and entrepreneurs strive to fill. By this time, the previously available "better ways" inevitably have reached a point of diminishing returns, and competitive pressures are met by placing emphasis on engineering refinement,

value analysis, manufacturing techniques, and so forth.

This fact, coupled with the tremendous reservoir of knowledge built up in metallurgy, lubrication technology, thermodynamics, statistical analysis, and accelerated destruction testing, has permitted the manufacturer in today's competitive markets to make product decisions in which he balances "how far can we cut quality" with "and still produce a marketable product." The conscientious manufacturer is trying to compete with the less scrupulous one in a market wherein advertising budgets are often given a higher priority than additional metal gauges or improved quality control—a situation not unique in the air conditioning industry. We all learned in freshman economics, "caveat emptor." "Let the buyer beware" has been true since the first trader tried to outsmart both another trader and a prospective customer. In fields of consumer products which are based on highly sophisticated machinery, the buyer in most instances is not knowledgeable enough to evaluate relative merits between product A and product B. The result is an unfair match in which the consumer is being confronted by a gigantic organization of scientists, marketing specialists, and so forth.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) was formed for the purpose of assimilating and disseminating technical information concerning the air conditioning,

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heating, ventilating, and refrigeration industry—a challenge which the society has coped with to an enviable degree of success throughout a most dynamic period of technological development. Now, the society must, in keeping with its stated purpose, recognize that the area of technical information includes the area of *standards*, with consideration of safety, capacity, and what are discussed here as durability, reliability, serviceability, and maintainability. How can these latter parameters be separated from the former? What good results may be achieved to standardize methods for determining and publishing capacity ratings if a device will only function, say, at the indicated capacity for a short initial period of time? In other words, what happens if the device lacks durability? I maintain that it is absolutely imperative for ASHRAE to pursue the four parameters of durability, reliability, serviceability, and maintainability.

Product quality must be considered

I am associated with a consulting engineering firm; I have an engineering education, and I was virtually raised in the industry. I can boast some 20 years experience in different involvements in the industry. This has enabled me, just like other systems designers or so-called consulting engineers to make a reasonably good evaluation of a product, assembly, sub-assembly, or component. However, this evaluation is, for the most part, qualitative rather than quantitative, and in many cases is partly based on the reputation of the manufacturer, since information on the components and subassemblies of the finished product is not available. And let me be quick to say that it is frustrating, though not unusual, for consultants to misjudge the durability, reliability, serviceability, and maintainability aspects of a product. At times it can lead to a very sticky or embarrassing situation. For, aside from being a systems designer, the consulting engineer is also an "evaluator of machinery." That is, one of his primary responsibilities is to evaluate and judge products on their relative merits of cost and the mentioned four characteristics which, if considered as an integrated parameter, are normally referred to as "quality."

The fact that ASHRAE formed a task group to study the possibility of a quantitative standard or standards of measurement for these parameters first came to attention through the program for the Society in a recent meeting. The topic greatly appealed to me because for the past few years I have been teaching a graduate course in HVAC systems design. I include in each lecture as a subtopic "comparative evaluation." The usual parameters of cost, energy economics at full- and reduced-load conditions, life expectancy, reliability, and availability of skilled technicians for maintenance and service inevitably generate such student response as the question, "How does an inexperienced engineer make such an evaluation?" The science of functionality, capacity, design feature analysis, and operating cost analysis is rather well defined (except for the part- or reduced-load energy consumption). However, the only reply that I can give an inquisitive student is that aside from the comparison of metal gauges and other superficial parameters he can only base his evaluation on experience. In essence that puts him and his potential client on notice that his ability to evaluate is a direct function of experience; thus he is without a yardstick, and there is virtually no way he can measure these four parameters. It is about time we gave him that yardstick.

Suggested basis for standards

Without going into a lengthy discussion on the advantages of these standards for the ultimate consumer, the scrupulous manufacturer, the contractor (bidding in a competitive market), or the commercial user, the following comments are offered as conceptual seeds on how such standards could be established by ASHRAE and utilized by the consultant who is presumably a knowledgeable buyer. Not all evaluation and measurement techniques can be mentioned here. What is offered is just a preview of the possible areas. For example, whenever an attempt is made to categorize, the decision of delineation must be made, i.e., do we align vertically or horizontally? A vertical delineation would be to take such parameter as serviceability and assign it a

listing of various devices. The same can be done for reliability, and so forth.

In a horizontal delineation, each product or device is considered, then the rating methods for that product are evaluated. For the sake of argument, let us consider a horizontal delineation for a single product, also one of the more simplistic product components. It is needless to point out that the more compound the product, the more complex the analysis. Take an air-cooled condenser as an example. Assume further that an air-cooled condenser consists of a coil, a housing, and a fan. For this device, it is desirable to have a means of measuring qualities of serviceability, durability, reliability, and maintainability.

Serviceability as proposed should be a means of measuring or evaluating the performance of the "rated" capacity under actual conditions to be expected in normal use. Thus, the serviceability could be expressed as a safety factor on heat transfer calculations (what in water-cooled apparatus is called fouling factor). Thus, we could simply rate this unit as having a serviceability of 1.1, 1.25, or whatever, so that the consumer can measure the safety factor or compare service expectancy to competitive products.

Durability is more difficult to "rate" since gauges of materials, such as fins and tubes, become secondary when manufacturing ingenuity is applied. However, the measurement of durability must inherently provide a method of evaluating the product in its ability to withstand the abuse of wear and tear as well as normally anticipated abuse which would result in damage and shortened usefulness. Thus, for any given family of products, the standards agency would establish a listing of the yardsticks for the manufacturer to achieve. Such yardsticks might be: (1) protection of aluminum fins from abuse resulting in flattening; (2) protection of resilient mountings from drying up or hardening (due to ultraviolet decay); (3) ability of heat transfer surface to resist fouling erosion or corrosion; (4) protection of electrical components from moisture damage. A set of measurement techniques would then be established, and each of the yardsticks rated independently on a scale from

1 to 10. The durability rating would be the average of these measurements. This would enable the agency to add relevant measuring parameters, or remove those that become obsolete, without changing the meaning of the rating.

Reliability, as I see it, is a double-jointed parameter and easiest to determine after some experience, or knowledge of service life, since the matter is simply one of statistical compilation. All major manufacturers have, or should have, this data on their products. However, this can be looked on as statistical evaluation before the fact, for when a product is developed or proposed, it is most difficult to predict reliability in such a completely revolutionary or new basic device. However, in a new arrangement of components or subassemblies, a simple statistical search of the components and subassemblies should provide an accurate prediction of the unit statistics.

Back to our example of an air-cooled condenser. Considering the subassemblies and components, the statistical reliability of the heat transfer surface and coil would be the experience of the given manufacturer concerning joint leaks or ruptures on similar coils. Similarly, other devices such as motors, bearings, supports, relays or contactors, either would have a statistical history or could be subjected to accelerated statistical failure tests. In the statistical rating method, the weakest link would necessarily determine the strength of the entire chain, and the rating would be determined by the failure history of the product, brought to a base of 10. Products too new to achieve a rating would be so rated until the necessary information is available.

Maintainability is perhaps the simplest preventive parameter no less important than the others. Every manufacturer should be required to provide in all engineering application catalogs and in installation instructions contained in product shipping kits the following information: (1) dimensional clearances needed around the device or product for effective service and maintenance access; (2) component parts listing by exploded view isometrics and part numbers; (3) accurate and easy-to-read maintenance instructions.

For example, on our air-cooled condenser, if clearance is required adjacent to and above the unit to remove the protective screen and clean the condenser, such dimensional clearance should be indicated; likewise for the removal of the fan assembly above the unit.

Clear maintenance instructions

The maintenance instructions to be passed on to the owner should not be multiple choice, such as "If yours has one of these, do this," but rather should apply to that user's specific product. Such instructions might simply be that monthly, during the season of use, the following should be done: (1) inspect the heat transfer surface for dust or other obstructions and clean, if necessary; (2) inspect electrical relay or starter contacts for pitting or corrosion and replace or polish as necessary; (3) inspect resilient mountings and lubricate with silicone lubricant (Ajax No. 123), if necessary; (4) check lubricant level in oil cups on motor bearings and lubricate (with No. 10 S.A.E. lubricant), if need is indicated; (5) inspect belts for tightness and wear, and adjust or replace, if necessary. What I am proposing is not to have a subjective rating on maintainability but rather to certify the item as an approved rating on maintainability, if the maintenance requirements are accurately stated by the manufacturer. The buyer can then apply his own evaluation.

These concepts are not entirely new. The heat exchanger manufacturers for years have had their serviceability evaluation in the form of a fouling factor (although admittedly this has been abused by some unscrupulous manufacturers in our industry). Durability evaluation has only been available in the industry as a matter of judgment on the part of the consuming public. More often than not, in the interest of "the safe side" philosophy, it resulted in unjust evaluation of some manufacturers' products. Reliability statistics have been available only to the manufacturers where they have been used as an effective tool in evaluating available components. However, the buying public has been kept ignorant of this valuable data. Maintainability information is made available upon special request, but usually only in the multiple choice configuration.

I am not naive enough to believe that a product evaluation or rating system could come about in the near or even not so near future. However, such a system appears to be an absolute necessity if the industry is to survive as a bastion of free enterprise. But if the seed is planted now, a full-grown tree will eventually reach its full maturity. I propose that ASHRAE lose no more time in planting this seed, for the sake of stabilizing the industry and protecting consumers as well as manufacturers of integrity.