The Responsibility for Reliability

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We have come to the third gathering of the world community of the art, science and practice of shot peening to share our work and our mutual fascination with this great phenomenon. The manipulation of surface stresses of metals has great prospects of service to the world society. Each one of us has personal contributions in mind to making one or several of those prospective benefits come to pass.

Important as the contributions of productivity, cost, and product improvements are, there is an overriding consideration that we, as this special world community, must address. This is the need to challenge the world aerospace industry to maintain and possibly improve its standards and practices related to reliability. The unique central body of the International Scientific Committee on Shot Peening might play a significant role in this issue.

The image of the great fireball down range from Cape Kennedy on January 28th of last year surely is etched in our memories. We were harshly reminded that competence in science and engineering is the ultimate source of safety and reliability in air and space travel.

While the achievements of Lindbergh, Messerschmitt, Bleriot, De Haviland, Earhart and other early airborne aviation pioneers are legend, hundreds of others have accomplished the miracle of aircraft reliability. While it is true that Charles Lindbergh was the first to fly from New York to Paris, it is also true that the Ryan Company's "Spirit of St. Louis" was the first airplane to complete the trip.

The miracle of modern flight is evident daily when, worldwide, an average of 2.4 million people board commercial airliners on missions of business, commerce, and pleasure with the confident expectation that they will arrive safely, if not on time. Every day the world's young military pilots fly their planes at speeds above Mach 2, training for battles and wars that we hope will not happen because we have such capabilities. Behind this, and the emerging era of space travel and manned space stations, is the concept of reliability.

This concept came early in the history of the airplane. Never lacking adventurers to take the risks, aircraft pioneers launched pilots into flight and celebrated their safe landings. But with the development of airliners, airmail, fighters and bombers, it became increasingly evident to designers and manufacturers that greater safety assurance required the development of procedures. The alternative was that operations would be too dangerous and the costs too high.

With the advent of rocketry and our new expensive vehicles, the issue of reliability became even more critical. How many planes, pilots and crews costing tens of millions could we afford to lose? How many ballistic missiles or launch vehicles priced in the hundreds of millions could we spare?

It was evident from a series of sometimes classic examples that reliability had to be built into each critical part of an airplane or vehicle to assure the performance of the whole. Before World War II, we advanced from the drawing stage to the specification. Each part had to work. The critical ones had to be studied for their functional performance and prospective failures. Performance might be specified but was always a function of materiel, alloying constituents, shape, surface smoothness, cycles to failure, maximum stress and other such matters as induced compressive stress on the surface by shot peening.

It was through the genuine concern of scientists, design engineers, manufacturing superintendents, foremen, workers and technical and general managers that this art of reliability was developed. Their mission was to make pieces of airplanes, weapons and space vehicles that would not fail. In the aggregate they produced what, thus far, is mankind's finest industrial accomplishment.

There were general specifications and technical orders prescribing characteristics of metal alloys, heat treatment procedures, cutting tools and procedures, machining, chemical milling and shot peening. To give assurance of results in shot peening, general specifications were developed for saturation testing of media, for machinery, for processes, for testing coverage and for destructive testing. As new knowledge was developed, specifications were modified. Scientists and design and manufacturing engineers worked with technical sales and technical service persons to develop that which was technically required and commercially feasible. When technical requirements could not be met by commercially available products, then new products had to be made commercially available. Customer to vendor interaction formed the technical marketing relationships that characterized our industry in the 1960's and 70's.

There was a quality assurance requirement. In the best circumstances, vendors and customers developed quality control relationships and quality assurance loops. Where necessary, they developed quality assurance technology.

There was a spirit among the serious companies in the world aerospace industry; it was a powerful feeling that we could provide needed safety and performance. The scientific discoveries, engineering advances, and new concepts contributed by men and women came from a confident feeling that "we could do it". I believe this was the dominant element of the industry's success.

I'm sure most of you are aware that this feeling has changed. A new philosophy among the military customers has spilled over to the commercial customers. Their thinking seems to be, "Thank you for building these nice, safe high performance vehicles and weapon systems, but now we must be cost effective".

This phenomenon, also known as cost-benefit, originated in the McNamara era of the U.S. Department of Defense. It implies that effectiveness might be purchased at high prices but, if the price is too high, it is not cost effective. Similarly, benefits might be purchased at most any price but, if the cost is too high, it is not cost-beneficial.

Cost effectiveness or cost-benefit, when applied to the aircraft and aerospace industry, can be beneficial as it trims away waste. The process, however, can be distinctly counter-productive if it trims away reliability. Unfortunately, the critical nuances of reliability often do not escape unimaginative cost cutting.

You will recall the highly publicized capture of the American Intelligence Ship, "Pueblo", by North Korean Patrol Boats in 1968. Its crew of some 40 men was imprisoned and the headlines were filled for months with their suffering and the distress of the United States. Value engineers in the Pentagon reportedly had determined that arming that vessel sufficiently to repel an attack by light craft was not cost effective.

I have heard cases and arguments about how shot peening to prevent a similarly unexpected risk of stress corrosion might also not be considered cost beneficial.

More insidious is the purchasing of shot peening services and shot peening equipment and media from unqualified low bidders. In the United States, this has played a role in the financial destruction of two inter-urban helicopter companies. There have been other disasters and an unknown number of in-line rejects with hemorrhages of extra costs.

We who are responsible for shot peening have a challenge in this era of cost cutting and cost effectiveness. While it may seem palpably obvious to us what must be done, we still have to argue it to make sure it happens.

Shot peening cannot be done by amateur corporations or people who do not understand the technological issues. Shot peening must be done under controlled circumstances where the angles, impacts, velocities, depth of compression, saturation and media are of the proper and required quality. Shot peening has brought great benefits to the aerospace industry; it also has brought issues of control and proper application.

The questions about shot peening might be:

"Why can't we buy cheaper equipment?"

"Why can't we buy cheaper media?"

"Why can't we get cheaper services?"

While there may be some disagreements among us, there are sound production engineering and quality assurance reasons for using high quality equipment properly engineered for a task. There are similar reasons for using media that fully meets specifications and for establishing specifications that provide for the best available commercial product to be used. Bitter experiences have proven the need for proficiency in shot peening services and for the detailed qualification of vendors.

Perhaps in the earlier days we were more careful than necessary. But who really knows what is necessary? We certainly have seen overwritten specifications but, if cost effectiveness is to be key, we must be certain that the effectiveness comes before the cost.

There is a task of maintaining the integrity of our discipline and arguing for the proper standards. The issue is not static but, rather, is dynamic. Standards must change and advance along with technology and performance requirements and capabilities.

Even if the emphasis is on cost, as it may be outside the aerospace industry, there are often cases where materials are wasted, labor time is increased and productivity is decreased by attempting to save money in the wrong way. Proper engineering standards are those that produce cost effective results. Abridging these standards for initial savings which cause greater expense in the long run is hardly rational action.

It is likely that the substance of the issue is attention to detail. Unwise cost savings often are based on omission of essential details. Shot peening failures sometimes occur because practitioners wholly misunderstand or wholly deceive, but are more often the result of inattention to detail, omission of detail or the elimination of a step. Perhaps the quality control of shot peening media for roundness or gradation might be omitted because, after so many decades of use, a young engineer asks, "Why are we doing this?", and no one can answer the question except to say, "Because we always did it".

As the leaders of the discipline we have an important responsibility to ensure widespread understanding of the essential details and their importance. It is up to us to write and speak to our colleagues about it; to teach it before classes; and to reinforce it in the minds of shot peening practitioners. It is far better to argue the reasons for the details and the technical issues, than to argue with insurance adjusters or before judges.

I referred in the beginning to a possible role of the International Scientific Committee. Are there some publications or pronouncements that should be coming forth from it to support those of us who must argue for quality and effectiveness? Should the Committee try to help inform those who must make judgements? I suggest that the Committee should play a role in shot peening reliability. While coordinating our triennial Conference is an important contribution to our discipline, reestablishing reliability concepts may be critical to its future.

Shot peening is one of the most cost effective processes known to the metallurgical industry. To cheapen it is irrational. But if the irrational happens, who is responsible?

Do we blame the cost accountants or the purchasing agents or the auditors? I suggest not. Rather, it is the responsibility of the leaders of the discipline.

We are those leaders.