AEROSPACE STANDARIZATION

Commercialism and the Need for Industry Integration

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Standards govern nearly everything that mankind produces. From initial design to final operation, standards ensure that products will work "properly, interactively, and responsibly."[1] Though generally going unnoticed, standards play a vital role in all aspects of the economy, particularly in those industries rooted in science and technology. Aerospace is one such industry that has been a focal point of America's technological leadership for the last century.[2]

For decades, the United States has been the unconditional leader of aerospace standardization. Recently, the U.S. industry experienced a shift in standards control from the government to commercial entities. This transition, although intended to strengthen the aerospace community, has ultimately weakened its infrastructure through decentralization. To alleviate this problem, standards bodies throughout the U.S. must work together to integrate the industry and promote healthy business practices. By unifying standards at the national level, the U.S. will be better equipped to successfully compete in all aerospace markets throughout the world.

One of the most difficult obstacles facing standardization organizations is the pace at which the aerospace community is advancing. Spurred by a number of new ventures, such as space tourism, the aerospace market is continually expanding its bounds. This rapid growth, in turn, demands the creation of more robust and commonly-accepted standards. The ability of U.S. standards developers to effectively meet these needs is crucial to the success and future of the entire aerospace industry.

EARLY ATTEMPTS AT AEROSPACE STANDARDIZATION

Following the end of the Cold War and the subsequent decrease in defense spending during the late 1980s, government contractors began to explore the relatively new commercial aerospace sector. About the same time, the U.S. Department of Defense was looking to implement a "single process initiative." This plan aimed at eliminating contract-specific requirements in favor of commonly accepted commercial practices in hopes of standardizing the means by which contracts were drafted and fulfilled. The ultimate result, in theory, was to achieve better consistency through an already convoluted supply chain.

The United States, meeting with some of the world's other leading aerospace contractors, determined that an internationally accepted standard should be employed throughout the industry. Their attention turned towards the already existing International Organization for Standardization's (ISO) 9000 quality standard as the de facto benchmark to follow.[8] These standards were focused on both management and assurance as a means to effectively document, maintain, and track an efficient quality system.

The ISO 9000, "as well suited as it was for standardization, was too general to serve for long as the aerospace standard."[9] For one, its standards were not specific to any one industry. Additionally, it did not address regulatory requirements for quality, safety, or maintainability which are not only unique, but vital, to the aerospace industry.[8] These shortcomings led many aerospace companies to develop their own set of quality standards to independently address the requirements set forth by the ISO 9000. As a

result, contrary to its intent, the ISO 9000 caused “even more fragmentation within the industry and higher costs than before.”[10]

REDEFINING AEROSPACE STANDARDS

Recognizing the need for an aerospace-specific version of the ISO 9000, a number of major U.S. aerospace prime contractors collaborated in 1995, within the scope of the American Society for Quality (ASQ), to form the American Aerospace Quality Group (AAQG). Their initial attempt at an aerospace interpretation of the ISO 9000 standard yielded the ARD 9000. During that same period, the AAQG also aligned itself with the Society of Automotive Engineers (SAE).[8] SAE, aiding in the release of the new standard, enabled the primary government regulatory agencies associated with the industry (FAA, DoD, and NASA) to thoroughly review the document in its draft stages. The final product, renamed AS 9000, was officially released in May 1997.[10]

The AS 9000 was significant for a number of reasons. It rightfully concentrated on the fundamental processes in the aerospace industry that affect safety, reliability, maintenance, and performance.[8] It also defined the co-dependent relationship between the regulating authorities and their respective businesses which, in effect, freed aerospace companies from having to develop separate quality systems. Following its release, the AS 9000 received widespread support throughout the U.S. aerospace industry.[10] These quality standards eventually extended beyond national horizons as the AS 9000 format was adopted by reputable aerospace organizations and standardization bodies throughout the world. SAE continues to be the cognizant authority in the U.S. for the AS 9000 series. The most current version, Revision B, was

released by SAE in 2004.[3] On a global scale, the European adaptation, EN 9100, is maintained by the European Association of Aerospace Industries (AECMA) while the Japanese version, JISQ 9100, is handled by the Society of Japanese Aerospace Companies (SJAC).[8] As evident by its various revisions, the AS 9000 series of aerospace standards is a living, breathing document. Its future success and utility, however, is heavily dependent on its ability to keep pace with an ever-evolving market.

LINGERING COMPLEXITY

Although the AS 9000 series offers a glimpse into the evolution of aerospace standardization, it only serves as one piece in the overall market picture. Many other standardization bodies stake claim in the aerospace industry and at different levels. SAE, with the AS 9000 series, is at the industry-wide level of standardization. It shares its purview with such organizations as the Aerospace Industries Association (AIA), the American Institute of Aeronautics and Astronautics (AIAA), and others which look at the overall health of the aerospace industry. Additional standards organizations, including the American Society for Testing and Materials (ASTM) and the Institute of Electrical and Electronic Engineers (IEEE), look at aerospace standards at the component level. The third, and final, tier of aerospace related standardization societies are focused on cross-industry standards. These organizations include the American Society of Mechanical Engineers (ASME) and the American Welding Society (AWS) which look at standards that extend outside of any one industry.[2] Table 1 illustrates a large spectrum of major standards developers within the aerospace industry.

Currently, the number of overall standards in the U.S. is estimated to be greater than 300,000. Of these, the aerospace industry is responsible for approximately 10%. A new study by the AIA-sponsored Future of Aerospace Standardization Working Group estimates that this percentage is significantly lower than the actual number. According to the Working Group, the percentage is closer to 35% when accounting for the "design, development, operation, maintenance, and disposal," of an aerospace product. Compared to other industries, the aerospace market is one of the most regulated with respect to standards, with practically 40% of all engineering and manufacturing data being standards-based.[2] Consequently, as with other technology-centered industries, the aerospace market is changing faster than the standards are able to keep up. The efficiency of the standardization process, therefore, rests with the leadership and infrastructure of the industry's standards developers.

INTERGRATION AND LEADERSHIP

"The aerospace industry spends a significant amount of money on standards. Managed well, it's an investment; without management, it's an expense." [15]

Standards are generated at all levels within the aerospace industry.[8] National policies, industry demands, and company requirements are only a few sources from which standards are born. To a certain extent, every developer of a standard has the ability define the scope of its application. This broadly open environment, though beneficial in some respects, has ultimately resulted in a "confusing landscape of overlapping scopes and often duplicative standards."[2] In its simplest form, this problem manifests itself in a lack of industry-wide leadership and open communication. To help

resolve these deficiencies, the Future of Aerospace Standardization Working Group, in its 2005 report, identified five areas of leadership which are required to be addressed.

First, and foremost of these areas, was the basic need of leadership for standardization. In order limit standardization inefficiencies, there must be a venue in place which allows the respective stakeholders to voice their ideas and offer opinions. This forum, as proposed by the Working Group, would neither serve as another standards development organization (SDO) nor attempt to resolve all issues. Rather, it would provide an arena in which all parties with a vested interest could meet on neutral grounds, collaborate on issues of concern, and collectively formulate the best means to go about these matters. The main intent of this venue would be to supply administrative direction via an open consortium of the industry's senior leaders. These leaders would not only prioritize the standardization needs of industry, but also designate which standards body would be best suited to address each issue.[2] The result would be a transparent decision, visible to all participants, which would eliminate the redundancy of independently generated standards.

Implementing the recommendations of the Working Group, the Executive Committee of the Aerospace Industries Association (AIA) approved the establishment of the Strategic Standardization Forum in the beginning of 2005. It was created under the official precept of "providing leadership, guiding activities, and addressing issues related to aerospace manufacturing standardization."[11] The success of such a venture is highly dependent on the number of participants and the scope of representation. Although the leadership is at the hands of the industry's most established standardization organizations, the consortium must be representative of all reaches of the aerospace

business sector. Because of this fact, it is crucial that the aerospace industry recognize and account for the private companies vying for a place in the market. As demonstrated by other industries in the past (i.e. the airline industry), these private companies can prove to be the commercial leaders of the future.[16] Therefore, it is recommended that the Standardization Forum open its doors to those private companies already establishing themselves at the forefront of their respective sectors. In doing so, the Standardization Forum can account for the direction that the entire commercial market is heading which, more often than not, is ahead of their government counterparts.

The second area of concern was leadership for global standards. Much effort has been made by standardization bodies to unite associated standards at an international level. The Americas Aerospace Quality Group (AAQG) and the International Aerospace Quality Group (IAQG), for example, jointly produced several quality management systems related to the AS 9100 series of aerospace standards.[12] Though beneficial at their own level, the fact still exists that no single entity is overseeing the global relevance of such standards. The aerospace industry requires a unified body at the global level to promote the use of standards as a means of achieving an environment based on the World Trade Organization's (WTO) principles of "openness, transparency, impartiality, and consensus."[13] The ultimate goal of establishing this type of atmosphere is to create a level playing field in which standards that are in the best interests of the industry can visibly enter the aerospace market for all to recognize and adopt. A secondary benefit is the mitigating effect this open environment has on locally generated standards intended to gain a competitive trade advantage.[2]

In addition to maintaining an open market for standards, the global leadership body would be tasked with identifying those standards which are best suited for the global market, regardless of their entry point. In other words, standards derived from US-based international standardization groups (IEEE, ASTM International, etc.) or global aerospace organizations (i.e. IAQG) cannot be refuted by "true" international standards developers (ISO, IEC, etc.) as holding no weight. Global standards, as defined by the Working Group, must be "globally recognized, accepted, and used."[2] This definition does not distinguish a standard based on its origin but, rather, its merit and applicability in the global marketplace. The challenge, therefore, is encouraging as much of the global market as possible to participate in introducing valuable standards to the leadership body.

At the national level, the Working Group's third suggestion expressed the need for unified leadership within the United States. As the aerospace market becomes integrated into the global marketplace, the U.S. should have a common voice to convey its stance when participating in outside venues. If employed correctly, this voice could effectively be an extension of the Standardization Forum already in place to collect industry-wide concerns within the U.S.[2]

Although similar to leadership for standards, the Working Group's fourth proposal went so far as to distinguish the importance of leadership for an optimized standards system. In its fundamental form, this proposal would serve as a robust feedback and monitoring system for the aerospace industry. It called for the collaboration of companies and organizations of all sizes to provide a unified wave of feedback to the standards developers. In doing so, individual sector concerns would carry the weight of

the rest of the industry and its needs. To implement this, another forum was recommended to field each concern prior to routing any ideas back up the ladder to the standardization organizations. The leadership in this forum would provide oversight with the intent to eliminate overlapping standards and scopes. Additionally, this forum would track all aerospace standards which are currently in-use, as well as those in development, in order to further prevent duplicative efforts.[2] Taken as a whole, the purpose of this venue would be to maximize efficiency by eliminating possible pitfalls at the lowest level. Even with the other leadership programs in place, the redundancy and incompatibility of newly proposed standards would only hamper their performance.

The last idea conveyed by the Working Group was leadership for education, awareness, and advocacy. This concept supplements all of the other plans in that it aimed at attracting participation from those entities which can add valuable input to the standardization process. In order to generate support and business involvement, this plan called for the spread of information voicing the advantages of standardization to the business sector. Case studies, among other training aids, would be utilized to convey the significance of standards to senior management. The means to go about formulating standards, along with the other life cycle factors (maintenance, distribution, and use) would be communicated to the industry members as well.[2] Increasing the number of participants in the standardization process only adds to the validity and strength of the resulting standards. This is important, as in the case of the emerging space tourism market, to attract participants early so that standards can be more firmly established as additional private companies enter the market. In this way, standards

can attempt to keep pace with the industry and promote safer, more cost-efficient business practices.

The underlying theme evident in all of these proposals is the desire to gain the most viable standards, for the largest business population, with the least amount of discrepancies. All of this translates to lower cost and a more efficient economic infrastructure. Standardization, by nature, "can lead to lower transaction costs in the economy as a whole, as well as to savings for individual businesses."[14] What, then, would discourage an organization from not participating in standardization? The answer is money. Standards cost money to develop, maintain, and use. Figure 1 illustrates some of the cost factors involved in developing standards.

In 1971, the AIA attempted to calculate the cost of adding one new part to the pool of standards parts. The estimate came out to over $20,000 (not adjusted for inflation), with the development and maintenance stages accounting for over half of the cost. Moreover, according to a 1998 study, items included on a Qualified Parts Lists (QPL) can cost an additional $7,000 with the extra testing and audits invloved.[2] The incentive, therefore, for businesses to form an interactive relationship with standardization organizations is multifaceted. Businesses benefit from having access to standards in the form of long term savings while lending input for newer standards. Leadership within the standards groups wants to attract companies by providing robust, well-defined standards to eliminate the need of additional, and costly, standards. Finally, both profit by providing safe, quality products that ultimately enhance the reputation of the market and attract more customers.

MANAGING QUALIFIED PARTS AND MATERIALS

"For aerospace, industry working closely with DoD is key to the creation of standards which will be value-added for both military and commercial use" [2]

Aside from the complexities associated with the development of standards is the need to document the parts and materials which meet these requirements. The aerospace industry, more so than other industries, involves an immeasurable amount of parts due to the inherent nature of its business. The corresponding program to manage these materials must be equally robust as the components for which it is accountable.

Standards define every aspect of the components employed in the aerospace industry. Commercial and government regulating agencies then determine the minimum standards which must be adhered to throughout the certification process for a given product. Like the other industries before it, the Department of Defense (DoD) served as the primary regulating agency for most of the aerospace industry's early parts and materials. The DoD used military standards (MILSTDs) and military specifications (MILSPECs) to establish the requirements necessary to qualify a component for use. As defined by the Office of the Under Secretary of Defense for Acquisition & Technology, specifications are used "to describe products, material items, or components" while standards "describe methods, processes, or procedures."[6] Since the 1950s, the DoD has maintained a comprehensive inventory of all certified parts and materials on a Qualified Product List, or QPL. For years, the DoD conducted or oversaw all testing and inspections performed on products to be listed on the QPL. These QPLs were also adopted by the early commercial aerospace industry in the production of aircraft.[2]

The mid-1990s, however, saw a shift in the existing infrastructure of the QPL system as the commercial market began spreading throughout the veins of the industry. The Secretary of Defense, William Perry, issued a 1994 memorandum giving preference to performance specifications and commercial standards over MILSPECs and MILSTDs.[6] The intent of this measure was to take advantage of the best commercial standardization practices while sharing the life cycle burdens associated with the development, preservation, and revision of these documents. This, in turn, would enhance the ability of standards to keep pace with the quickly changing market.[2] Though considerably different from their original objectives, "the overall consequences resulting from [this] reform are still being felt today."[7]

The transition from government to commercial control was not without its downfalls. As DoD standards, and their associated QPLs, migrated over to a consortium of commercial standardization organizations, the industry effectively removed its primary qualifying agency. This left no central authority in place to oversee the necessary handling or maintenance of these technical requirements. Furthermore, the existing infrastructure of the aerospace industry did not support the continued management of QPLs. Not only was the commercial sector lacking the industrial base to perform the requisite testing and inspections, but there was no method in place to absorb the cancelled MILSPECs into their own standards system.[2]

To help alleviate the communication obstacles experienced during the conversion process, the AIA formed the Early Warning Project Group (EWPG). This group was tasked with identifying specific DoD cancellations and pairing them with appropriate, and technically equivalent, Non-Government Standard (NGS).[4] An NGS,

as its name implies, is any “standardization document developed by a private sector association.”[5] If a NGS was not found as a suitable replacement, the EWPG acted as a steering committee to find the appropriate commercial standardization body (i.e. AIA, ASTM, SAE etc.) to draft a new specification.[4]

The lingering issue of maintaining an all-encompassing QPL remains to be resolved. Several standardization organizations, having recognized the need for third party qualifications, have affiliated themselves with specific qualifying agencies. SAE International, for example, has established a relationship with the Performance Review Institute (PRI) while the AECMA in Europe has formed its own subsidiary, AECMA-CERT. In contrast, the AIA, which received a significant number of MILSPECs during the transition phase, still does not have sufficient measures in place to retain a QPL. Despite any efforts at an organizational level (SAE Int’l), doubts still remain as to the industry-wide acceptance and responsibility for the funding, managing, or maintaining of a viable QPL.[2]

The solution to this problem is not a simple one. Prior to the MILSPEC and MILSTD reform, it was imperative for the DoD to oversee the testing and qualification of its own components to ensure proper operation on the battlefront. Being a single entity, the ability to account for and control a QPL was well within its capacity. Even after military standardization was dispersed throughout the commercial aerospace industry, the concept of a unified body to manage a common QPL still has merit.

The Future of Aerospace Standardization Working Group, consistent with its other recommendations, advocates an industry forum as a means of working towards this goal. In its efforts, the commercial industry should work closely with the military and

vice-versa. The military not only has the most experience in managing QPLs, but it is also the largest consumer of these components. Furthermore, the DoD demands certain specifications of their commercial products and must ensure that these requirements are not only contained, but met, in these standards. The advantage of this forum, as in others, is that it affords all sectors of the aerospace community a voice in the development of a feasible management strategy for an industry-wide QPL. Included in this strategy should be the conditions which determine whether or not a given standard ought to have a qualification requirement, the means by which to properly insert a qualification requirement into a specification, and the plan to resolve outstanding QPL requirements for standards ignored in the transition process.[2] Transparency of the process in the commercial market will ultimately determine the success of the final product as it is the customers who will most use the QPL.

CONCLUSION

Standards play an integral role throughout the aerospace industry (see Figure 2). The rapid pace at which the industry is expanding poses a unique, but difficult, challenge to all standardization organizations. The ability to effectively identify, create, and issue widely-accepted standards in a timely manner is a complex problem in much need of improvement throughout the U.S. and the world.

The AIA, among others standards developers, has offered several solutions to the existing industry flaws in an effort to form a more unified aerospace community. The AIA's report, although idealistic, does provide a vision for what the industry should strive to emulate. Analyzing the described recommendations, it is apparent that global

integration must start at the national level. The U.S. must continue to lead the aerospace market by establishing a successful model for the rest of the world to follow. To do so, the U.S. must blend all aspects of the industry into one venue to collectively harmonize its standardization infrastructure. Private, commercial, and government entities must work together not only to integrate the aerospace market within itself, but within other industries. This collaborative effort, in turn, would extend the influence and voice of the U.S. aerospace industry to the global level.

The strength of the aerospace industry in the U.S. is highly dependent on the relationship between the government (DoD) and the commercial sector. As illustrated in the aerospace market, the government set the stage for the commercial sector to enter and eventually control. Now that the DoD has taken a more passive role with respect to the management of standards, it does not remove them from the process. Being the largest consumer of aerospace products, the DoD must still remain at the forefront of the standardization process. The closer that the government and industry collaborate, the more value will be added to the market as a whole.

Overall, the U.S. aerospace community should take a more proactive role in its attempt to integrate standards. Even though related standardization organizations are often vying for the same customers, they are, in effect, preventing the very concept which they promote – efficiency through uniformity. That is not to say that competition should not exist among standards developers but, instead, should promote enough openness and communication between different entities to ensure homogeny, vice contradiction, of standards. More foreign standardization groups are establishing themselves everyday in an attempt to gain a bigger piece of the world's market. The

ability of the U.S. to remain at the top this market depends on its collaborative efforts as a nation.

TABLES / FIGURES

Table 1
Aerospace Standards by Key Standards Developing Societies

Presented at the1st International Aerospace Standardization Workshop, Montreal, Canada, 2003

	AIA	AIAA	ARINC	ASME	ASTM	DoD	EIA/GEIA	IEEE	IPC	ISO/IEC	SAE
						(45)					
Avionics			177			27	10	11			28
Bearings	51				2	97				44	89
Cargo Handling	1			87	2	13				36	61
Chemical	3				27	216					73
Composites	3				4	29					467
Computing Hdwr.						17	25	13			26
Configuration Mgmt					1	5	32	4			-
Couplings, Hoses & Tubing	136			49	13	396					1122
Data Management	2					56	2			13	-
Deicing	4					3				3	32
Drafting	6			28	1	19		2			-
Elastomers	1				6	41					187
Electrical/Electronics	155	1			2	2420	170	32	12	54	533
Environmental		1			2	14				3	81
Fabrics					11					2	-
Fasteners	2513			108	4	935				90	1079
Finishes	9				11	219					210
Fire Safety											-
Fluid Power Sys.	12					122				73	154
Fuels & Fuel Sys.	3			21	59	57					58
Ground Support Equipment	16					6				14	65
Human Factors		1			1	17	4	1			167
Information Mngmt.						22				51	-
Instrumentation	1					121				10	97
Landing Gear	3					12				6	81
Lighting	1					56					44
Lubricants	5				2	85					17
Mechanical Parts (clamps, rings, rods, knobs, etc.)	285					316					-
Metals	59				238	432				18	1351
Network/Web								10			-
Nondestructive Tests	5				27	26				9	30
Non-Metallic Materials					61	490					
Oxygen	1				1	36					65
Packaging	59			7	6	87					28
Printed Wiring Boards						24			56		-
Propulsion Systems		3			1	23				1	244
Quality	5					19		2		12	16
Safety	5					6					40
Sealants					11	71					51
Seats	2					2					7
Software Eng.		4				13	25	17		7	13
Space Vehicles		17			3					27	-
Systems Engineering						41	3	14			-
Testing & Metrology	71	2			525	94		8	18	22	15
Totals:	3,417	29	177	300	1,321	6,685	271	110	86	495	6,571

NOTE: Totals for AIA, AIAA, ARINC and SAE are total aerospace standards developed by the society
Totals for all others (because they are not aerospace unique standards developers) are those identified as being used by The Boeing Company

*Copied from “The Future of Aerospace Standardization,” The Future of Aerospace Standardization Working Group, Aerospace Industries Association of America, Inc., January 2005. 25 June 2007. http://www.aia-aerospace.org/library/reports/aerospace_standardization0105.pdf.

FIGURE 1

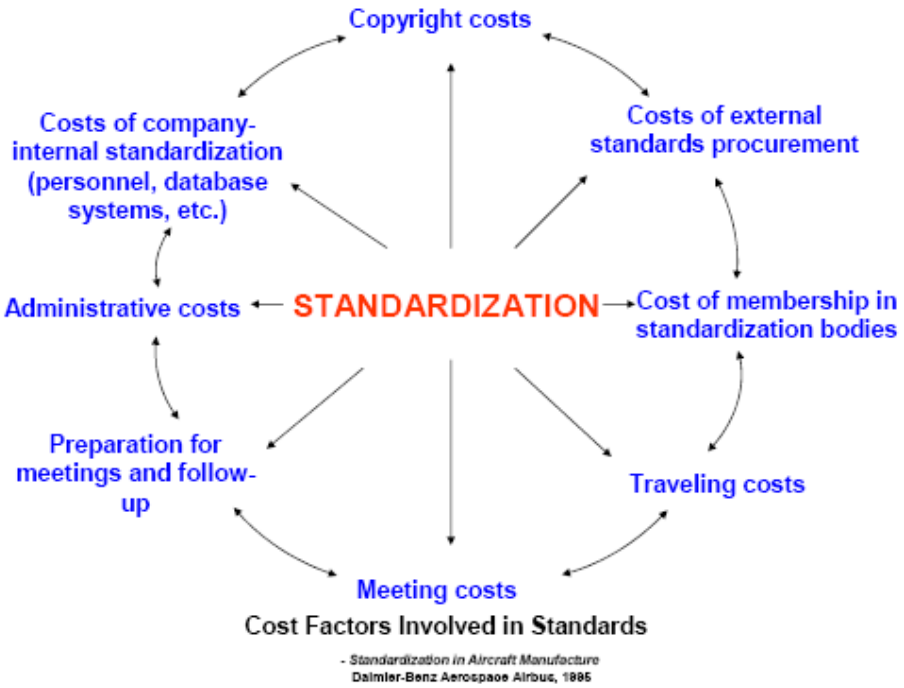
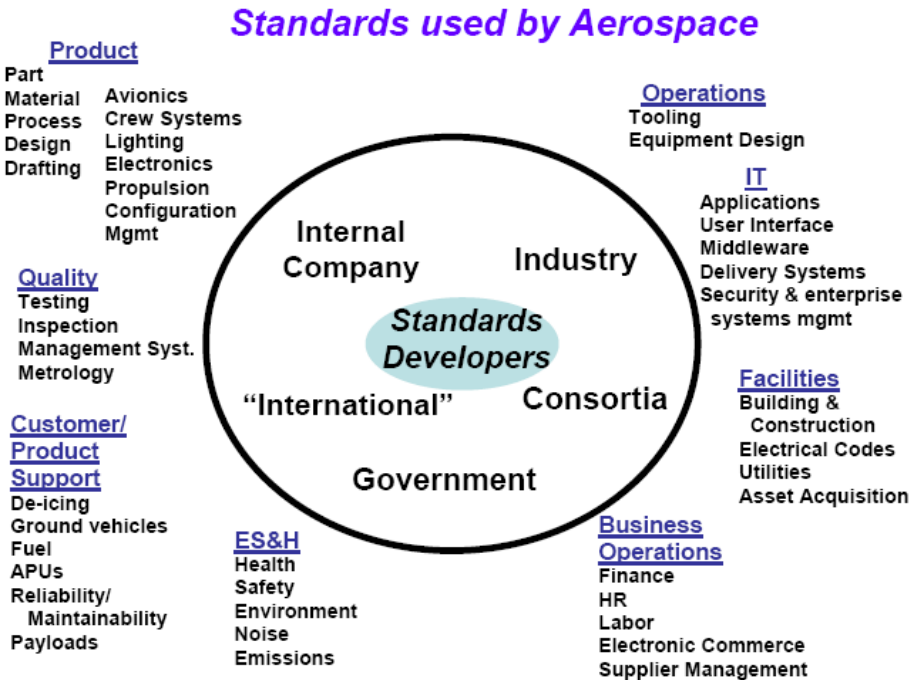


FIGURE 2



*Figures 1 and 2 Copied from "The Future of Aerospace Standardization," The Future of Aerospace Standardization Working Group, Aerospace Industries Association of America, Inc., January 2005. 25 June 2007. http://www.aia-aerospace.org/library/reports/aerospace_standardization0105.pdf.

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