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The Influence of International Standards on Opto-mechanical Design

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ABSTRACT

In the last 10 to 15 years, a considerable body of international standards literature has been published on both mechanical and optical design. We discuss the influence of these internationally developed standards on the design and fabrication of optical systems. We conclude that while there are large benefits to be gained from using these international standards, there will have to be a substantial educational effort at all levels from project scientist to worker on the shop floor to take advantage of the benefits. Many sources to help in this education process are outlined.

INTRODUCTION

While this paper is about the influence of internationally developed standards on opto-mechanical design, we start by indicating that there is no direct influence. The standards developed by the International Standards Organization (ISO) are voluntary standards and can be used or not used as any manufacturer sees fit. The influence of these standards will, rather, be felt indirectly through such forces as having to bid on components specified according to the ISO standards, not having market access to certain countries unless ISO standards are used and met or because some customer mandates the use of international standards in the design and fabrication of some product.

Because there is no direct connection between the ISO standards and the need to use these standards, it is the thesis of this paper that an extensive educational process must take place before the benefits of the ISO standards can be truly recognized. This paper is an attempt to begin that process and point out the various sources of further information about the international standardization effort.

We begin by giving a little background about international standards work in general. As part of this background, some of the theses upon which international standardization is based are discussed.

Then we move on to technical areas of direct interest to the opto-mechanical designer and outline some of the standards work done in these fields. The actual work in optics has been very recent and much of it is still in the draft form. However, these drafts are readily available for study and use in areas where there is presently no other suitable method of specifying needed features on optical components.

Once we have outlined much of the available ISO literature, we discuss other sources of opto-mechanical standards literature and comment on that literature. We then address the problem of introducing the features of the new standards into designs and drawings in sensible way. It seems to us that simply decreeing from some day forward that all drawings will be done using an certain format or that all parts will be inspected to a particular standard is counter productive. It is suggested that there is a method of gradual introduction that allows all involved to get acquainted with these new standards ideas in a logical and systematic fashion.

Finally, it is suggested that the move toward using the ISO standards begins at the top. The opticians and inspectors can only make and inspect what is on the drawings. It is the project leaders and designers that start the process of using these new tools. Before using the tools, however, these same people must be familiar with the standards and the advantages they offer.

Because the ISO standards in the opto-mechanical area are substantially more thorough than the existing national standards, it is like giving a craftsman more and better tools to work with. With the better tools, the work itself will become better. In this time of increased competition, we all need all the new tools we can get to keep up.

BACKGROUND

Efforts toward international standardization began early in the 20th century at a meeting in the United States. It was the rapid spread of electrification that served as the stimulus for the International Electrical Congress of St. Louis to pass a resolution "that steps should be taken to secure the cooperation of technical societies of the world by the appointment of a representative commission to consider the question of standardization of the Nomenclature and Ratings of Electrical Apparatus and Machinery".[1]

The 'commission' that resulted from this resolution was the International Electrotechnical Commission (IEC) founded in 1906 with headquarters in Geneva, Switzerland. While this international standards body is concerned with electrical and electronic matters, the objective of the Commission so well states the purpose and methods of international standardization that we quote it. "The object of the Commission is to promote international co-operation on all questions of standardization and related matters in the fields of electrical and electronic engineering and thus promote international understanding. This object *inter alia* is achieved by issuing publications, including recommendations in the form of international standards, which the National Committees are expected to use for their work on national standards, in so far as national conditions will permit."[2]

There are several key features in this statement of objectives aside from the principal one of promoting international understanding. First of all, the IEC is a *voluntary* standards organization. The use of its standards are not mandatory and the extent of any use is up to the individual national committees. Of course, there is nothing stopping a governmental body (national or otherwise) from adopting an international standard into its own regulatory code. At that point, the standard becomes mandatory in the region where the governmental body has jurisdiction.

Another feature is that membership in the IEC (and as we will see below is similarly in ISO) is by "National Committee". The national committee in the United States is the American National Standards Institute (ANSI), a private standards coordinating and approval organization that has been appointed by the US Government to fulfill this role. The US is the only country whose National Committee is a private rather than a government organization. This creates more than a few problems in international standardization because ANSI cannot speak for the US Government whereas all the other national committees can.

The next big push in international standardization came after World War II when the International Standards Organization was established as part of the United Nations Charter. ISO is also headquartered in Geneva and physically housed in the same building as the IEC. ISO has the responsibility for coordinating and approving standards in all fields of technology except those under the narrower IEC charter. Of course these days almost everything uses electronics and electricity in one way or another so the dividing line is fuzzy. The IEC and ISO have been working hard at "harmonizing" their rules and procedures so that the approval criteria and cycle for new standards is the same. There are also some "Joint Committees" between the two groups in the areas of computer and image formation technology.

ISO was founded in 1947 at a meeting of the national committees of 25 countries. The National Committee for the US is ANSI. Other national committees that may be familiar are the British Standards Institute (BSI), the Deutsches Institut fur Normung (DIN) and the Association Francaise de Normalisation (AFNOR). A complete list of all the national committees belonging to ISO along with addresses and phone numbers are listed in the ISO

Memento[3], an index of members and technical committees.

In terms of how it functions, ISO has over 190 Technical Committees (TC's) representing fields of technology from Tractors and farm machinery to Micrographics and optical data storage. One of the ISO national committees heads each of these TC's and serves as the secretariat or administrative body for the TC's it heads. Further, each TC is broken down into several Subcommittees (SC's) that again have national committees that serve as secretariats. Within the SC's are Working groups (WG's) where the actual standards writing gets done. Some of the TC's most closely allied with opto-mechanics are listed in Table 1.

STANDARDS WRITING PROCESS

Now that the organization of ISO has been explained, the process of writing standards will be discussed. We will describe not only the mechanism behind the standards writing but also some of the guiding principles. At first glance, some of the procedures look somewhat cumbersome but there are well thought out reasons for doing things according to the procedure. On the other hand, the system has a great deal of flexibility. This permits reasonable people to accomplish the difficult task of coming to consensus without the burden of too rigorous a set of rules to contend with. Of course, too, the secretariat has a great deal of influence on how some matters are dealt with even though they are supposed to be completely neutral.

Before any standards work is undertaken, there has to be a consensus of the national committees that there is the need for standardization in a particular area. If the technical area is outside the scope of any existing TC's, a new TC will be formed and given a scope that defines its work. In the case of the TC we are most interested in, TC172 - Optics and optical instruments, it was formed in 1979 because many of the other TC's were writing application oriented standards that dealt with optical principles. However, since each TC consid-

Designation	Technical Committee Name	Secretariat
ISO/TC10	Technical (mechanical) drawings	DIN
ISO/TC12	Quantities, units, symbols, etc.	SIS
ISO/TC36	Cinematography	ANSI
ISO/TC42	Photography	ANSI
ISO/TC57	Metrology, properties of surfaces	GOST
ISO/TC112	Vacuum technology	GOST
ISO/TC130	Graphic technology	AFNOR
ISO/TC171	Micrographics	AFNOR
ISO/TC172	Optics and optical instruments	DIN
ISO/TC180	Solar energy	SAA
ISO/TC187	Colour notations	SIS

Table 1
Various ISO Technical Committees Related to Optics

ered the optical aspects from its own applications viewpoint, there was a lack of consistency between the work of the particular TC's. It was this concern over consistency that led to the consensus to form TC172.

Almost always, the initiative is taken by one national committee to undertake new work. In the case of TC172, it was DIN, the German Institute for Standardization. Because DIN had a long record of standards writing for optics it was easy for DIN to write a scope for the technical work and then solicit other national committees to join it in establishing the TC. Implicit in this effort was that DIN would volunteer to be the secretariat for the TC and that the first chairman for the group would be a representative of the German optics community.

At the inaugural meeting of TC172 in Pforzheim, Germany, the various national delegates were asked to volunteer for being the secretariats of the 9 SC's originally proposed. Because there was little interest in the technical scope of some of the SC's, some were not initially activated. Within the activated SC's, Working Groups were established and appropriate scopes agreed upon. Only at that time was the structure in place to begin writing standards. Table 2 shows the structure of ISO/TC172.

Once the structure was in place and the scope of the technical work was agreed upon for each SC and WG in which there was interest, the procedure is then to place those applicable national standards on the table and use them as the basis for an international standard. In the case of optics, the Germans had a long history of work in this area while few other countries had done much. Thus the basis for much of the ISO work in optics is based on DIN standards.

TYPES OF STANDARDS

The type of standards writing is also considered important. Basically there are three types of standards, those dealing with vocabulary or nomenclature, those specifying test methods for products

Subcommittee		Working Groups		Secretariat
SC1	Fundemental standards			DIN
		WG1	General optical test methods	DIN
		WG2	Indications in optical drawings	SNV
		WG3	Environmental test methods	DIN
SC3	Optical materials and components			AFNOR
		WG1	Raw optical glass	DIN
		WG2	Coatings	ANSI
SC4	Telescopes			GOST
SC5	Microscopes			DIN
		WG3	Terms and definitions	AFNOR
		WG4	Interfacing imaging optics	ON
		WG5	Stereo microscopes	ANSI
SC6	Geodetic instruments			SNV
		WG1	Terminology	DIN
		WG2	Tests	SNV
SC7	Ophthalmic, endoscopic, metrological instruments and test methods			DIN
		WG1	Endoscopes	JISC
		WG2	Tonometers	DIN
		WG3	Other ophthalmic instruments	DIN
		WG4	Tests for contact lenses	ANSI
SC8	Ophthalmic optics			AFNOR
		WG1	Contact lenses	BSI
		WG2	Spectacle frames	DIN
		WG3	Corrective lenses	AFNOR
SC9	Electro-optical systems			DIN

Table 2
Organizational structure of ISO/TC172 - Optics and optical instruments

and those setting performance criterion for products within the technical field in question. It is necessary to work on the nomenclature first so that all parties agree what it is they are talking about. This work also helps clarify what are the important aspects of the work to follow.

Next, a series of standard test methods or procedures must be worked out. These are generic test methods for some specific performance aspect of the products in that technical field. For optics, these might be tests for resolution or OTF, or they might be environmental tests that simulate the conditions that real instruments would see under actual use. Depending on the use, the test conditions could be made more or less severe.

Finally, standards involving the actual performance of instruments or products are written. These might involve such things as what uniformity in resolution must an instrument have to be labeled as having a flat field or what uniformity in illumination must a copy lens have over the specified working field of view. It is clear now that the first two types of standards must have already been in place before the performance standard can be written. Obviously too, it takes a real knowledge of what is desirable and feasible in terms of real instrument performance to write a performance standard.

This talk about the types of standards also helps illustrate a point or define terminology that is sometimes used regarding standards. Some standards are referred to as being horizontal while others are vertical. A horizontal standard is one that applies to all aspects of a given technological field. In the case of optics, a standard that defines how to do a drawing of an optical component would be a horizontal standard because it applies to all optical instruments. On the other hand, a standard dealing with the thread size for microscope objectives is a vertical standard because it only applies to microscopes.

When it comes to writing performance standards there can be conflicts over what SC's have the responsibility for writing performance standards.

For example, environmental tests for optical instruments are obviously horizontal standards but are the people who wrote these broad based standards the best informed people to apply them to, say, microscopes. The microscope people would say no, and, in fact, at the last Plenary meeting of ISO/TC172, the vertical standards writing SC's were given the last say over performance standards although the horizontal and vertical groups are supposed to work together.

REQUIREMENTS OF STANDARDS WRITING

While this gives a feel for the mechanisms for writing standards, we have said little about the content of the standards being written and what are the rules for the content. First, all ISO standards must use SI units and the definitions that ISO has given for physical quantities. The SI units are given in ISO 1000-1981 - *SI units and recommendations for the use of their multiples and of certain other units.* This ISO standard and 14 other standards dealing with the definitions of quantities, units and their definitions are contained in *ISO Standards Handbook 2.* This Handbook and all ISO standards materials are available from ANSI[3].

Next, all ISO standards are written in English, French and Russian, the official languages of ISO. As a matter of actual practice, more and more, English is becoming the only official language of ISO. This is not official policy but the precedent for it started in the early days of ISO. At that time, it was agreed that Russian was an official language but that the Russians would have the total responsibility for translations both ways from Russian to English and back because they were the only ones truly qualified. As time went on, the French realized that they were holding up progress when the proceedings of the working group meetings had to be translated into French. Beside, most of the French attending the meetings spoke good English.

As a result of this, much of the actual standards work is written only in English (although the minutes of the meetings are done in both English and French). It is then up to AFNOR, the French National Committee to translate the final standard into French so it can be published by ISO in Geneva. If the French do not submit a suitable translation by the time the standard is to go to press, it is published in English only. This will probably be a more common experience.

Partly as the result of the above statements, but much more because there are so many other languages than just English, French and Russian, ISO standards make use of symbols wherever possible. The idea here is that the people actually making the product may not speak a word of English, but if they are familiar with the meaning of the symbols on an optical drawing, for instance, there will be no problem with its interpretation. Also it is up to the National Committee of any non-English speaking countries to translate the ISO standards into their own tongues.

Another aspect of ISO standards writing that is vigorously enforced is the making use of already written ISO standards when working on a new standard. Thus when ISO/TC172/SC1/WG2 was working on ISO 10110 - Indications in optical drawings[4], a standard on how to represent an optical element on a mechanical drawing, all the previously adopted mechanical drawing practice was used *in toto*. All the ISO mechanical drawing standards published through 1988 are bound together in two volumes. These are *ISO Standards Handbook 12, Technical drawings* and *ISO Standards Handbook 33, Applied metrology - Limits, fits and surface properties*[3].

Other things that are considered in the actual standard are the use of series of numbers in logarithmic progressions, for example. These progressions appear when preparing tables of, say, surface roughness. If one wants to cover a wide range of possible roughness values in a table, it makes more sense to divide the range of numbers this way rather than use a linear division. Also, the standards make use of tables of fits for shafts and holes such that if one knows the type of fit desired, it is simply necessary to look up the tolerance value in a table such as contained in ISO 286 - *ISO system of limits and fits*. This is the origin of the tolerances seen on European drawings where there is a dimension followed by, say, h8. This effectively means plus 0, minus something depending on the diameter of the part for shafts and external features. There is a corresponding H8 for the hole tolerance.

Somewhat along the same lines, many standards have default tolerances built into them. These are the tolerances on features not indicated on the drawing *per se* but covered by the default. The drawing should indicate that the default convention is being used. The default tolerances have the effect of making sure that non-toleranced features in fact have some reasonable but not tight tolerances.

For example, ISO 10110, Part 11 has default tolerances for 10 different features of lenses. These are all loose enough that 2 elements each made to the default tolerances would not work well together in a single lens cell, but at least the lenses would fit into laboratory type lens mounts so they could be adjusted relative to one another.

TECHNICAL ASPECTS OF OPTO-MECHANICAL STANDARDS

Now that we have covered many of the details of how standards get to be written and what some of the ground rules are for writing them, we turn to some of the technical details of interest to the designer and fabricator. Here we will not go into any great detail, but rather indicate the type of standards material available for study and use. Since they were written first and make up the foundation of opto-mechanical design, we will cover the ISO mechanical standards first.

As we already mentioned, the *ISO Standards Handbooks 12 and 33* contain all the mechanical drawing standards published through 1988. The ISO standard most similar to the US ANSI Y14.5M - 1982, *Dimensioning and Tolerancing* is ISO 1101:1983[5]. The forward to ANSI Y14.5M lists the few differences from ISO 1101 that existed in 1982. Those differences are being reduced steadily as the US and ISO work to "harmonize" these 2 standards. In addition to ISO 1101, however, there are 10 other ISO standards, all relating to various aspects of dimensioning, tolerancing and inspection.

Perhaps the most useful of these is ISO/TR 5460-1985 - *Geometrical tolerancing - Verification principles and methods - Guidelines*[5]. The "TR" in the title designation indicates that this is a technical report rather than a standard although it could be adopted as a standard if there were the consensus to do so. In any case, what makes this useful is that it is a companion to ISO 1101. For every feature designation in ISO 1101, ISO/TR 5460 shows in schematic form, kinematically correct methods for verifying that each feature meets the specified criteria.

In other words, for every kind of feature control call out, ISO/TR 5460 shows several examples of how to fixture the part to a surface plate and how to set up an indicator to verify that the feature is in tolerance. The effect of this technical report is to make clear in a functional way what each feature control call out means in terms of the instruments used to inspect the feature. Thus the TR 5460 can almost be used as a textbook to illustrate the meaning of the feature callouts in ANSI Y14.5M or ISO 1101. An example from ISO/TR 5460 is shown in Fig. 1 for verifying flatness.

Other ISO standards contained in *ISO Standards Handbook 33* that go far beyond US documents include ones on surface roughness. In the US we have 2 standards on roughness, ANSI B46.1 - 1978, *Surface Texture* and ANSI Y14.36, *Surface Texture Symbols*. In the *ISO Standards Handbook 33*, there are 4 standards dealing with definitions related to surface roughness, one on how to specify roughness and one on how to use a stylus instrument for measuring roughness. In addition, there are 2 standards covering 2 different methods of measuring roundness, either using a rotary table and stylus or using a V-block and indicator.

Principle 1 — Verifying flatness deviations by comparing with a flat element

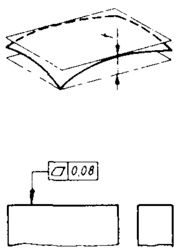
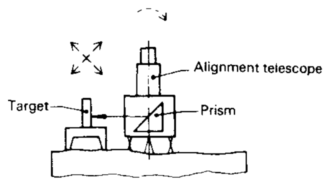
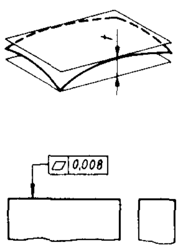
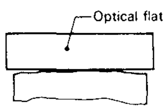
Symbol	Tolerance zone and application example	Verification method	Comments
⏥		**Method 8 1 3**  Place the alignment telescope on the object Align the rotating axis perpendicular to the superimposed surface of the object The flatness deviation is the maximum difference from the calculated superimposed surface	This method is suitable for large surfaces The alignment of the rotating axis can be corrected mathematically
		**Method 8 1 4**  Place the optical flat on the object and observe it in monochromatic light The flatness deviation is the number of interference lines counted, multiplied by $\lambda/2$ of the light used $\left(\frac{\lambda}{2} \approx 0{,}3\ \mu m\right)$	This method demands a highly reflective surface This method is practical only for small objects with flatness deviations up to 20 µm, depending on the size of the optical flat The optical flat should be adjusted to the object in such a way that the deviation is minimized

Fig. 1 An example of two of the methods for verifying flatness deviations as shown in ISO/TR 5460. (Example taken directly from ISO/TR 5460.)

The last part of *ISO Standards Handbook 33* contains 14 standards and recommendations on using the measuring instruments of precision engineering and inspection such as dial indicators, vernier calipers, external micrometers, roughness comparison standards and gauge blocks. The standard on gauge blocks, ISO 3650-1978, is ten pages long and gives information on 4 grades of gauge block accuracies, methods for measurement of their length and conditions of measurement.

Before leaving this topic, we should mention 2 US publications that bear on ANSI Y14.5M. These are a book called *Geo-metrics II*[6] by Lowell W. Foster and a text/workbook called *Design Dimensioning and Tolerancing*[7] by Bruce A. Wilson. Mr. Foster was vice chairman of the ANSI Y14.5 committee when the 1982 version of the national standard was published and remains active on the committee. He is also the head of the US delegation to ISO/TC10, the Technical Committee that wrote ISO 1101, among others. In his preface, Mr. Foster says "*Geo-metrics II* is dedicated to the promoting of standardization of engineering drawing techniques in support of ANSI Y14.5. This text is also dedicated to furthering worldwide efforts through the ISO and its standards and programs such as ISO/TC10/SC5 - Dimensioning and tolerancing".

The other book is written more like a textbook than Mr. Foster's and is a little more basic. If one did not know anything about ANSI Y14.5, Wilson's book is a good place to start. He considers ANSI Y14.5 the authoritative document and says that his book simply expands on the explanations given there. We think he is being rather modest.

INTERNATIONAL OPTICAL STANDARDS

We move on now to describe the tangible effects of the work of ISO/TC172 as it affects optomechanical design. At the moment there are 12 published ISO standards concerning optics and about 150 drafts of standards. Since we cannot possibly cover all these even by just mentioning the titles, we will give a general idea of what is available and how to get a listing of the individual titles.

All of the published and draft ISO standards concerning optics *per se* are listed on the SPIE electronic mail bulletin board, OPTOLINK. OPTOLINK maybe reached by dialing (206) 733-2998 by computer modem. If this is the first time calling OPTOLINK, you must give yourself a password. Once into the system, the main menu will let you select "Member services" and the second of these is "Standards". The listing of standards may be viewed screen by screen or downloaded to your computer so that you may look over the listing at your leisure. As the listing will tell you, the published ISO standards are available through ANSI[3] and the drafts from NAPM[4].

FUNDAMENTAL STANDARDS

ISO/TC172/SC1 - Fundamental standards, has been one of the most active SC's. There are 3 WG's in this horizontal standards SC working on Optical testing, WG1, Indications in optical drawings, WG2 and Environmental testing, WG3. Much of the work of WG1 has been standards on OTF definition and methods of testing. There are also some standards on the measurement of distortion and veiling glare.

All of WG2's time has been spent working on a 13 part optical drawing standard, ISO/DIS 10110. When adopted, this will be the defining document on how to do a drawing representing an optical element or subassembly. The standard includes how to indicate the mechanical features of an element that are unique to optics, how to specify the material properties, figure, centering and surface imperfections. There are also sections on indicating surface roughness or texture including a power spectral density method, coatings, default tolerances and laser damage threshold. Fig. 2 shows a lens element drawn according to the principles of ISO 10110.

ISO 10110 is a parallel standard to ANSI/ASME Y14.18M-1986, *Engineering drawings and related documentation practices - Optical parts*, and the surface imperfection part of ISO 10110 is parallel to ANSI PH3.617-1980(R1985), *Optical elements and*

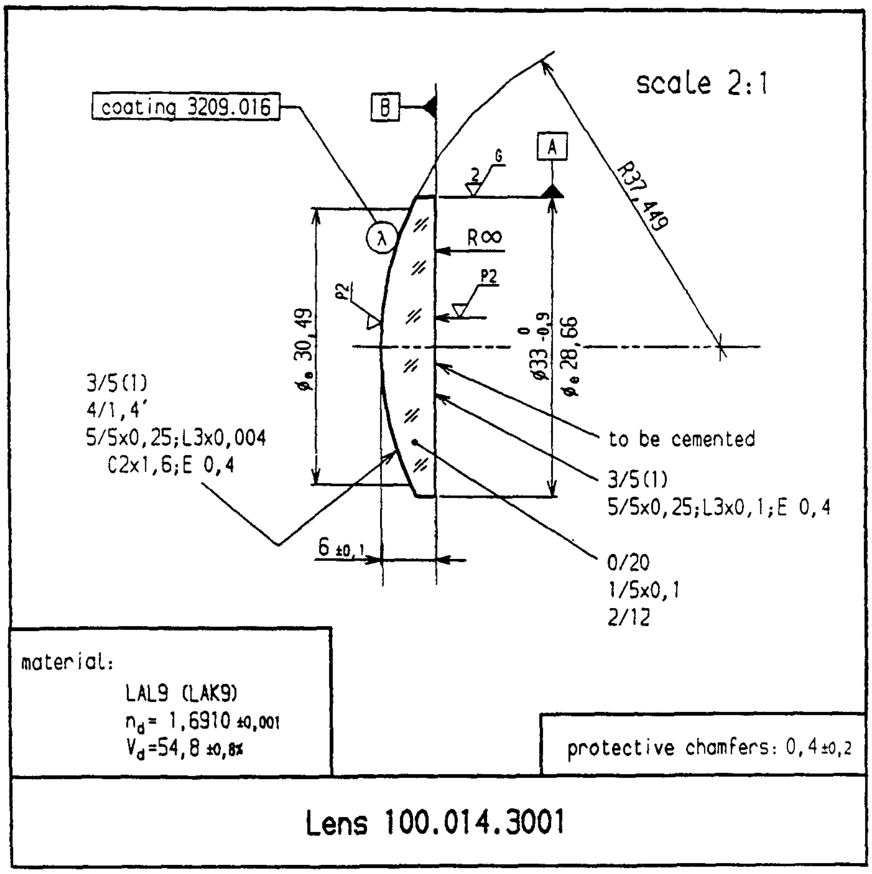


Fig. 2 An example of a simple lens drawing done according to ISO/DIS 10110, Part 1. Notice that the specifications concerning strain birefringence, bubbles, inhomogeneity, striae, figure, centering, surface and coating imperfections (or beauty) and surface roughness are all given in symbolic notation so that notes concerning these specifications do not have to be translated from English.

assemblies, definitions, methods of testing and specifications for appearance of imperfections[3].

In WG3, they have been working on the specification of 20 or so tests of environmental testing conditions applicable to optical instruments. They are now beginning to write vertical requirements standards for various types of optical instruments. These standards specify the severity of the environmental tests depending on the type of service the instrument is likely to see in the field.

OPTICAL MATERIALS

There are 2 active WG's in SC3, one dealing with clear optical glass, that is, not filter glass, and on dealing with optical thin film coatings. WG1 has written several standards about the tests that specify the durability of optical glass under various climatic conditions but otherwise has not done too much work.

On the other hand, WG2 has been quite active and has written a 4 part standard, ISO/DIS 9211 on optical coatings. The 4 parts cover a definition of terms, the specification of the optical properties of thin film coatings, the environmental durability of coatings and a set of tests to demonstrate this durability. This document is far more encompassing than all the US MIL coating specs put together.

MICROSCOPES

Subcommittee 5 has been working on standards relating to microscopes and associated hardware such as slides and cover glasses. There are 5 published standards and 14 drafts from this group.

MEDICAL OPTICS

The title of this SC is somewhat misleading since most of the work concerns ophthalmological instruments and many aspects of the measurement of contact lenses. It also includes chemical and biological test methods relating to contact lenses. Anyone interested in design criteria relating to ophthalmological instruments is sure to find a wealth of information here. There 9 draft documents on these instruments. There are an equal number of drafts relating to the testing of various optical and biological properties of contact lenses.

OPHTHALMIC OPTICS

In this SC there are 3 WG's working on contact lenses, spectacle frames and corrective lenses. There are a total of about 15 drafts rather evenly distributed over the 3 WG's.

ELECTRO-OPTICAL SYSTEMS AND LASERS

This is potentially the most influential SC in TC172. There are 7 WG's in this SC, 6 of them working on laser related standards and one just getting started working on E/O systems. The activity in the laser area has been due to European Community pressure. One of the first things the EC is standardizing is tools and machinery used in production. Since lasers are used for materials processing, there is extreme pressure to work out a suitable set of international standards before the Europeans write their own standards. Since DIN is the Secretariat for both the European Standards Organization (CEN) and for ISO, the Secretariat has encouraged the ISO delegates to work hard and fast so these standards only have to be written once.

The various laser WG's are

WG1 - Terms, test methods and test instruments for lasers,

WG2 - Interfaces and system specifications

WG3 - Safety

WG4 - Laser systems for medical applications

WG5 - Laser systems for general applications

WG6 - Optical components and their test methods.

The work in these groups has progressed in 2 years from no committee to draft international standards in most cases. One has to look to OPTO-LINK just to keep up with the pace of the work in this area.

The work in WG7 - Electro-optical systems other than lasers, is headed by the Japanese Industrial Standards Committee (JISC), the Japanese national committee. They are interested in working on standards related to liquid crystal displays, integrated optics, infrared imaging and interferometry, both white light and laser sources. They will be starting with definitions and terminology and working into interfaces and quality requirements.

This covers the specifics of what is being worked on at present in international standards for optics and optical instruments. As is readily apparent, there is activity in almost all areas of optics and as standards relating to quality requirements are adopted, it will have a great impact on everyone in the optics field. While it will take a time to adjust to the new standards, the benefits in the long term are bound to be positive.

ADOPTION OF INTERNATIONAL STANDARDS

There are 2 issues concerning the adoption of new international standards, one is the legalistic issue and the other is the practical one. For thoroughness we will treat the first issue briefly but spend most of our time on the second, really important issue.

There are really 2 stages of adoption of an international standard. The first stage is a vote by all the national committees that participated in the writing of the standard as to whether or not to make it an international standard. The committees are saying at this point, yes, we agree that this is the standard we all wrote together and that our countries have no overwhelming objection to it. This vote does not have to be unanimous; "If 75% are cast in favor of the DIS, it is accepted for publication as an International Standard"[8].

At this point, the national committee in each country can decide whether or not to adopt the standard as a national standard. In the US, the ANSI/NAPM OP Committee would be the body that would actually vote on this issue after an announcement had been made in the ANSI *Standards Action*[3] and a public meeting has been held. Even prior to such a vote, the US military could, for example, adopt ISO 10110 as the new MIL spec for optical drawings. This action would make ISO 10110 a "mandatory" standard as far as the military were concerned.

Before we leave this discussion of the procedures followed during the adoption of international standards, we should point out 2 other very useful documents. The first is the 3 volume set of *ISO Directives*[3] that describes in detail the entire ISO standards writing process. The first volume, *Procedures for the technical work*, describes the make up and management of the working groups doing the standards writing work. Included are many pages of sample forms for the secretariats to use in assigning work and distributing the results of that work.

The second volume, *Methodology for the development of International Standards*, goes into the technical details of how an ISO standard should be written. There is information on units, symbols, and the mention of "standard reference materials". The third volume, *Drafting and presentation of International Standards*, deals with the physical layout of the standard and addresses such items as paragraph numbering, topic ordering and references to other ISO documents. This set of documents is necessary for anyone with the responsibility of a WG leader or higher in the ISO standards writing administration.

The other document needed by US people working in the international standards area is the ANSI publication, *Criteria for the Development and Coordination of the U.S. Positions in the International Standardization Activities of the ISO and IEC*[3]. This publication outlines how domestic standards writing and administrative groups in the US interface through ANSI with the ISO. It gives the rules for determining if there is US interest in certain technical areas, how to make sure that interest is broadly represented and how to present that interest in the ISO forum.

On the much more germane question of how do standards get adopted in a practical sense, we make 2 observations; companies that want work bid on what they are asked to make, and if a new optical drawing standard were put in place by *fiat* on some arbitrary day, there would be chaos. Taking a harder look at these points, if a drawing comes into a shop done in a new or peculiar format, the shop owner has 2 choices; he can return the drawing without bidding or he can learn what the new format means and then bid accordingly.

However, the shop owner will never make a part to a new standard unless he gets a drawing done in the new standard. For this reason, if the new standard is used, it will first be used by the people doing the design work. Adoption of a new optical drawing standard will not be a grass roots process, it must come from the top down.

Regarding the second point, nothing as complicated as the ISO 10110 drawing standard can be adopted overnight. It will take weeks of study to get proficient with each of the 13 parts. It will be similar for other new ISO opto-mechanical standards. It seems that the sensible approach to any sort of change over from one system to another is to use the old system for all those features that can be adequately communicated with the old system.

For features that cannot be indicated using the old system, use the new system if it has a feature that describes what is desired. Note on the drawing by an asterisk (or some other appropriate symbol) the feature(s) indicated by the new standard and list the standard in the title block along with the old.

When a shop gets such a drawing, they do not immediately have to learn a whole new system. They have one or 2 new items to learn, a much simpler process and one less likely to illicit a "No Bid".

Presumably the shop manager will get a copy of the new standard, just as he would if a new MIL spec were listed, and see what is being asked for. If it is within his capabilities, he is now in an advantageous position over those shops that did not want to take the time to learn something new.

The next time he gets a drawing with these same new call outs, he is ready to go to work. If a new feature is added next time, it is still not a problem. Of course, as the new standard is used more and more widely, the learning process goes on. Before long, the shop will be familiar with the whole new standard because by the time you have become familiar with half of it, it is a little hard to ignore the rest of it.

To make the learning process easier, the Optical Society of America is going to publish a "Handbook"[9] on ISO 10110 that takes each of the 13 parts and covers them in detail. The Handbook will interpret the standard and give the rationale for doing things as they were done in the standard. It will give examples of the application of the standard and contrast it with other standards the worker may already be familiar with. The Handbook will be to ISO 10110 as a book on using DOS is to the DOS Reference Manual. One has all the definitions and formats, the other tells how to use it.

CONCLUSION

We have shown that there are many international mechanical and optical standards either published or being reviewed as drafts. These standards and draft standards are readily available to use as guidelines for new design work. It was indicated that these new standards will not be used if they are not brought bear at the highest levels of design. Management must encourage the use of these international standards so that newly designed products will have access to all world markets.

It was also indicated that the adoption of the new international standards should not take place all at once but in a gradual move away from the present way of doing business. The new standards should be used where they can convey unambiguous meaning as to what is desired and where it is impossible to convey this meaning with the older standards or methods of doing things. As companies and their workers gain experience with the new standards, the switch to using all international standards will be that much easier.

REFERENCES

[1]*Statutes and Rules of Procedure*, International Electrotechnical Commission (IEC), Geneva, Switzerland, 1986, p. 5.

[2]*Op cit.*, p. 5.

[3]Available from ANSI, 11 West 42nd St., NY, NY 11036.

[4]Available from the National Association of Photographic Manufacturers (NAPM), 550 Mamaroneck Ave., Harrison, NY 10528.

[5]Contained in *ISO Standards Handbook 33*.

[6]Addison-Wesley, Reading, MA, 1986.

[7]Goodheart-Willcox, South Holland, IL, 1992.

[8]*ISO Memento*, 1990, Geneva, p. 5.

[9]Available from the Optical Society of America, 2010 Massachusetts Ave. NW, Washington, DC 20036.