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NATIONAL AND INTERNATIONAL DRAWING STANDARDS:
MOVING TOWARD BETTER ALIGNMENT WITH Y14.5

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REA

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ABSTRACT

The task of revising the national standard on Dimensioning and Tolerancing, begun seven years ago, required close coordination between the Y14.5 Subcommittee and the U.S. expert members who participated in related activities of the International Organization for Standardization. The revised drawing standard about to be issued reflects additional international alignments in areas of metrication, symbology, and conventions. Differences remain in the prescribed symbol for indicating a datum feature and in a Principle of Independency, the latter unacceptably absolving size limits from controlling the geometric form of an individual feature. More U.S. member experts will be needed on the Y14.5 Subcommittee to uphold US viewpoints in the writing of international drawing standards of a pragmatic kind.

IT IS A PRIVILEGE to be invited to this Aerospace Congress on the 75th anniversary of SAE and to speak on the topic of drawing standards. Specifically, I want to explain how a soon-to-be-published revision of the Y14.5 standard on Dimensioning and Tolerancing stacks up against the standard of the International Organization for Standardization (ISO).

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This standard coming out is just one in a series of U.S. drawing standards bearing the "Y14" designation. It is an important one because it covers the basic principles of dimensioning and tolerancing, the standard practices used in expressing the design requirements for a part or component on an engineering drawing. Coverage is comprehensive, ranging from the fundamental rules of dimensioning to the precise controls that are invoked by specifying geometrical tolerances.

The SAE co-sponsors with ASME not only the Y14.5 standard but others in the series. The support and representation received from SAE in these activities is recognized and appreciated. Thus, it is appropriate to give an audience of co-sponsors some idea of how we are meshing with the international standards. First, let me review events and circumstances leading up to the submittal of a Preliminary Draft for editing.

HISTORY

Seven years ago, the Y14.5 Subcommittee began work, with a meeting in St. Louis to plan revisions to the standard. A series of four-day meetings followed, held twice a year, coupled with much correspondence, and culminating with a meeting in San Diego earlier this year to finalize the draft. The new issue will be published shortly after the review and approval process (now underway) is completed.

Since the 1973 issue was published, members of the Subcommittee have been to a number of international meetings on dimensioning and tolerancing. These meetings have influenced the direction of change taken in the new issue while also broadening the base upon which the standard was developed.

As you know, international trade is affected not only by highly visible tariffs, but also by the hidden barriers of national standards. Because international standards are the common language by which

trading nations gain a technical and commercial understanding of each other, national standards must continue to seek closer alignment with them. The Y14.5 standard is no exception.

At a meeting in the Netherlands in 1972, the ISO outlined a program of work for its TC10 Committee and Subcommittees in the years to follow. A United States delegation attended this meeting and submitted ten papers on subjects recommended for consideration in the program of work for the ISO Subcommittee 5 on Dimensioning and Tolerancing.

Subsequent meetings of this ISO Subcommittee and its associated working groups have been held in various European cities each year since 1972. Participation in these activities is the only means by which the U.S. viewpoint can be registered and ideas offered to advance the cause of international standardization.

Several concepts and techniques of U.S. origin (and featured in the Y14.5 standard) have already gained ISO acceptance. They are the projected tolerance zone concept, three-plane concept, total runout tolerance, multiple datums and datum targets. As a matter of particular interest, the total runout tolerance idea first appeared in the old SAE Aerospace-Automotive Drawing Standards Manual. It was then called "composite form control." Notes were then used also instead of the symbology now used to specify these requirements.

During the development of the forthcoming issue, joint meetings were conducted with the U.S. Technical Advisory Group to the ISO Subcommittee on Dimensioning and Tolerancing. This group is comprised of certain Y14.5 members who are authorized to serve as technical experts when participating in ISO activities. Because of attrition, only two are now serving in this capacity. More of this later.

Joint meetings were beneficial, because all those indirectly involved were able to gain first-hand knowledge of emerging international practices. These practices were subsequently discussed by the Subcommittee and carefully evaluated as possible items for inclusion in the U.S. standard. While many were included (those considered practical and technically feasible) a few were not. They shall likely remain points of difference.

CONFLICTS

A long-prevailing example of one difference is the exception that the Y14.5 standard has taken to the ISO symbol, as well as the methods, for indicating a datum feature in geometric tolerancing applications. The basic symbol consists of a leader line, terminating in a solid triangle. The character of the indication on the originating end of the leader line depends upon the complexity of the part definition. In simple cases, the leader line is attached directly to the geometric tolerance frame. In more complex situations requiring remote indication, the leader line attaches to a separate frame containing the datum identifying letter. This letter is then referenced in the geometric tolerance frame.

Superiority of the U.S. symbol and methods of indication is readily apparent by comparison. One symbol is used for all applications, and the methods of indication are fewer and simpler. They are well-established practices, having first appeared on U.S. military drawings some 30 years ago. There is no valid reason to prompt a change.

In addition to this recognized difference, a conflict in principle has arisen about the interpretation of limits of size. As of this moment, ISO is proceeding with the adoption of a so-called "Principle of Independency" that absolves size limits from controlling the geometric form of an individual feature. This absolution is a significant departure from the established interpretation wherein a boundary of perfect form at Maximum Material Condition (MMC) is prescribed for controlling variations in geometric form as well as size of individual features.

This latter interpretation is attributed to an Englishman, William Taylor, who in 1905 was granted a patent covering "Improvements in Gages for Screws." The essential feature of his patent was that "GO" gages were to be "full form," thus simultaneously checking all elements at maximum material condition. The "NOT GO" gages would individually check various elements at Least Material Condition (LMC). This technique became known as the "Taylor Principle" and was subsequently applied as the general rule to all limit gaging.

If the Principle of Independency is adopted as the general rule by ISO, size limits of both material conditions (MMC and LMC) would be verified by caliper-type (two-point) measurements only. As a consequence, a nominally straight pin or shaft having acceptable cross-

sectional measurements could conceivably have the linear form of "wet spaghetti" without being rejected. Furthermore, where it is deemed necessary to control the form of a feature within its limits of size, ISO proposes to invoke an "Envelope Principle" (a boundary of perfect form at MMC, if you will) by placing after the size dimensions the symbol (E) on the drawing. At this point, some familiar expressions come to mind, such as "reinventing the wheel," and "a rose by any other name..." etc.

This approach is nothing more than the Taylor Principle applied on an exception basis, but requiring a special indication on the drawing to invoke it. It is predictable that there will be many of these indications required on drawings to ensure fit and function of mating parts. The Y14.5 standard will continue to endorse the Taylor Principle as the general rule which, traditionally, has required no drawing indication. No indication is necessary because it is a fundamental precept well established in product, tool and gage design. Additionally, Y14.5 will continue the provision for allowing exclusions and exceptions to the Taylor Principle where practical considerations so dictate. Examples of excluded items are stated in the standard, and specific exceptions must be indicated by a note on the drawing.

As an extension of the Principle of Independency, ISO proposes that all geometric tolerances apply independent of size limits, even when a feature is everywhere at its MMC size. The U.S. believes that this philosophy is impractical and unacceptable because every geometric tolerance would be additive.

Despite these significant differences, progress continues to be made toward commonality of practices. The impact of international standardization on the forthcoming issue of Y14.5 is reflected in three general areas of coverage: metrication, symbology, and drawing conventions. Let me describe briefly what has happened in these areas.

METRICATION

SI (metric) linear units are featured throughout the text and in illustrations. This is not to say that we have abandoned the U.S. customary (inch) system. On the contrary, practices peculiar to specifying dimensions and tolerances in inches will be provided for an indefinite period into the future.

Although the predominant featuring of millimetre dimensions and tolerances is expected to facilitate the metrication process, selection of the unit of measurement should be in accordance with the company policy of the user.

Millimetre dimensioning and tolerancing practices, with one exception, are those already employed by most metric countries. The exception is the comma, which is used neither as a decimal marker nor as a means of grouping digits by threes (to the left and right of the decimal point). A period (or point) will continue to be used for the decimal marker, and a space will group digits by threes.

A symbol method is introduced for specifying the toleranced size of a feature in accordance with a system of preferred metric limits and fits. The callout consists of the basic size, followed by a symbol composed of a letter and a number. Specific details on the system may be found in ANSI B4.2-1978, Preferred Metric Limits and Fits.

Initially, limit dimensions are to be specified, followed by the appropriate symbol identified as reference information. After sufficient familiarity is gained, the symbol will be specified and the limit dimensions identified as reference. Eventually, it is expected that symbols alone will be used to express these requirements.

Because the emphasis and ultimate goal is to design in metric units, information relating to dual dimensioning will no longer appear in the body of the standard. This information is, however, included in a new appendix on former practices. The new appendix will provide an interpretation of former practices, such as dual dimensioning, which may still appear on existing drawings.

SYMBOLOLOGY

Alignment of national and international practices is clearly evident in the area of symbology. To arrive at an internationally meaningful set of symbols one needs a dedicated effort to achieve commonality in principle as well as in practice. The geometric characteristic symbols displayed in the revised Y14.5 standard are the result of previous years of discussion and eventual refinement. Many of these symbols were introduced by the United States after World War II in military drawing standards, such as MIL-STD-8 and earlier ordnance standards.

Through the efforts of our British and Canadian colleagues, the symbols depicted in U.S. military standards were proposed and adopted by ISO--before the U.S. really became an active participant in the development of international drawing standards. Most of these symbols have retained their original form. A few have been modified to improve representational qualities.

Emphasis continues to be placed on the use of symbols as the standard means for specifying drawing requirements, wherever practicable. Well-designed symbols provide multi-lingual communication, helping to overcome language barriers so often encountered in the exchange of technical information between countries.

The late Henry Dreyfuss, noted industrial designer who had a professional interest in symbols, once equated them to "communicating without an accent." Once the proper meaning is established, a symbol conveys the same message to everyone without any dialectal sound effects. Nothing is lost in the translation from one language into another. The prudent use of symbols on technical drawings serves to enhance the graphical definition. A more rapid understanding will result and the drawing is less cluttered than one on which requirements are specified in note form. Improvements along these lines will be noted in the next Y14.5 issue.

Several practices formerly considered options are now standardized. They are the use of parentheses to identify a reference dimension (or reference data); the symbol to indicate "diameter"; placement of the diameter symbol (and the radius symbol) before the dimension; and the international sequence of entries within a feature control frame (formerly called a feature control symbol).

Symbols requiring a change in configuration to conform internationally include the total runout and the datum target symbols; these are necessary concessions to achieve commonality.

New items introduced are the ISO symbols used to indicate "spherical diameter," "spherical radius," "arc," and "square." In addition, unique symbols are introduced for specifying the taper of a cone and the slope of a flat taper as ratios.

The Y14.5 Subcommittee decided that it was prudent to introduce three new symbols in the next issue and submit them as candidates for adoption by ISO later. After careful deliberation, three frequently used terms used in specifying dimensions and tolerances were selected

for symbolization: "countersink," "counterbore" or "spotface," and "depth." These symbols have already received favorable comments from other English-speaking countries. If you want to see a comparison of the latest Y14.5 and ISO symbols, you will find it in an appendix to this paper. I won't discuss them at this time.

CONVENTIONS

The two international drawing conventions chosen for introduction in the forthcoming issue are those having dimensioning and tolerancing applications.

One involves the use of a thick chain line for indicating a limited length or area of a surface which is to receive particular consideration. The chain line, introduced as a standard line convention last year in Y14.2M, Line Conventions and Lettering, is drawn parallel to the surface profile and a short distance from it. Dimensions are then added for length and location.

The other is a method for specifying repetitive features and repetitive dimensions. A numeral followed by an "X" indicates the number of times (or places) they are required. Both numeral and "X" precede the feature size or locating dimension.

CONCLUSION

This has been a brief description of the extent of our latest efforts to align U.S. dimensioning and tolerancing practices with those adopted (or soon to be adopted) in international standards. It represents another advance taken by Y14.5 toward adopting international practices, wherever practicable--an effort which began with publication of the 1973 issue.

There are, of course, other numerous changes and improvements of the domestic variety that have not been mentioned. To do so in this presentation would occupy too much of your time.

THE FUTURE

While the central theme of this paper exemplifies the Y14.5 adaptations toward alignment with international standards, of greater

importance is ensuring future participation by United States experts in the development of those standards. You, the members of SAE, representing an impressive array of companies, can be of assistance in helping us bolster U.S. participation.

As the publication date approaches, signalling the end of our assigned task, resource planning for the next phase of Y14.5 activity will begin. It will be necessary to reconstitute Subcommittee membership with fresh talent to replace membership losses as a result of retirements and resignations.

We will be seeking candidates with an interest in standards development and possessing the technical knowhow in all aspects of dimensioning and tolerancing principles and practices. In addition to being members of the Y14.5 Subcommittee, the selected individuals will be requested to serve as technical experts representing the United States at ISO meetings abroad. Thus, candidates should be affiliated with companies or organizations willing and able to sponsor their travel, both domestic and foreign.

To protect and expand its export markets, American industry must participate in writing the drawing standards that have world-wide acceptance. Without adequate representation in the development of such standards, U.S. industry will suffer--because the industries of other nations, acting in a competitive international market, are attempting to drive home their point of view on every possible occasion.

We must be equipped to meet these challenges on the international scene in the years ahead. Technically proficient individuals (and enough of them) are needed to uphold the U.S. viewpoint and help develop practical and meaningful international drawing standards.

Hopefully, a future list of Y14.5 members will include individuals affiliated with companies represented at your 1980 SAE Aerospace Congress. Should this occur, our efforts will be sustained.

COMPARISON OF SYMBOLS

SYMBOL FOR:	ANSI Y14.5	ISO
STRAIGHTNESS		
FLATNESS		
CIRCULARITY		
CYLINDRICITY		
PROFILE OF A LINE		
PROFILE OF A SURFACE		
ALL AROUND-PROFILE		NONE
ANGULARITY		
PERPENDICULARITY		
PARALLELISM		
POSITION		
CONCENTRICITY/COAXIALITY		
SYMMETRY	**NONE	
CIRCULAR RUNOUT		
TOTAL RUNOUT		
AT MAXIMUM MATERIAL CONDITION		
AT LEAST MATERIAL CONDITION		NONE
REGARDLESS OF FEATURE SIZE		NONE
PROJECTED TOLERANCE ZONE		
DIAMETER		
BASIC DIMENSION		
REFERENCE DIMENSION	(50)	(50)
DATUM FEATURE		
DATUM TARGET		
TARGET POINT		

*MAY BE FILLED IN

**DELETED IN FAVOR OF POSITION SYMBOL

SYMBOL FOR:	ANSI Y14.5	ISO
DIMENSION ORIGIN		NONE
FEATURE CONTROL FRAME		
CONICAL TAPER		
SLOPE		
COUNTERBORE/SPOTFACE		NONE
COUNTERSINK		NONE
DEPTH/DEEP		NONE
SQUARE (SHAPE)		
DIMENSION NOT TO SCALE	<u>15</u>	<u>15</u>
NUMBER OF TIMES/PLACES	8X	8X
ARC DIMENSION		
RADIUS	R	R
RADIUS, COMMON	CR	R
SPHERICAL RADIUS	SR	SR
SPHERICAL DIAMETER	SØ	SØ