The attached document is a section titled *General Guidance to Companies Involved in Going Metric* from a U.S. Metric Association book, *Guidance for Companies Considering Converting Their Operations to Using the Metric System*.

The original edition of *Guidance* was published in 1991. It was revised in 1994 and 1997, but USMA no longer sells the book because it is long out of date. The attached section can nevertheless be useful as long as the reader bears in mind its age.

The standard mentioned on the first page has since been updated; as of this writing (late 2007) the newest edition is IEEE/ASTM SI 10–2002, *American National Standard for Use of the International System of Units (SI): The Modern Metric System*.

General Guidance to Companies Involved in Going Metric

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NOTE: The version of the metric system that will be used is known as SI (for *Système International d'Unités*) or International System of Units.

Designate IEEE/ASTM SI 10-1997, *Standard for the Use of the International System of Units (SI): The Modern Metric System* as the basis for company metric usage.

Planning for conversion to metric system usage should be unemotional and handled exactly as the company would handle development of a new product or system. View it as an opportunity to simplify operations by substantially reducing the number and variety of parts and components, and to improve operating procedures.

a. Company standards and specifications can be cleaned up, simplified, and improved during the changeover to metric.

b. Multinational companies will be able to communicate with the personnel in their overseas facilities in a common measurement language, with virtual elimination of errors due to converting from one measurement system to another.

c. It is probable that a major benefit will result in the reduction of inventories. When planning the conversion, most companies will find that (during design of a product) designers have a tendency to make small changes in a part or component when an existing similar part/component in the inventory will do the job, thus adding another item for inventory and warehousing.

   For example, when General Motors (GM) went metric, it found that its inventory of 900 fan belts could be reduced to less than 100 fan belts. The savings realized in inventory storage/control went far toward alleviating the cost of metric conversion.

d. During the planning stage, savings may be realized by reducing the proliferation of fastener sizes, wire sizes, measuring implements, and many other items which clutter up the storage areas.

   An example of benefit reaped by GM was its re-evaluation of the wire sizes it had been using. It was found that changing the wire size netted GM a saving of $1.6 million a year, which resulted in recovering the company's total cost of conversion within six years.

e. During conversion to metric usage, examining (in detail) the operations and procedures currently used for manufacturing, warehousing, purchasing, etc. can result in discovery of unnecessary steps, duplicated operations, and many other procedures that should be eliminated. This can yield more efficient operations with increased productivity and can provide accompanying savings in time and cost.

f. To help relieve the apprehension many employees will have when they learn the company is going metric, it is recommended that employee metric awareness be built at an early stage.

   Tell employees why the metric transition is necessary and inform them that only those actually using measurement units on the job will be affected. Assure those who use measurement on the job that plenty of training will be available for them. Use the employee newsletter to provide brief tips on how to remember metric units, giving them a general idea of how the metric units relate to the inch-pound units they have been using.

g. Training employees to use metric units need not be a major problem. The training can be accomplished via your training instructor's using video-taped lessons enhanced by hard-copy reference materials. To assist employees who may be slow learners in a classroom, set up a library-loan facility for video tapes and hard copy metric training materials so employees can check them out and view them at home or during lunch hour.

   The important thing to keep in mind for actual training sessions is **Train the employee only in the units he or she will be using on the job.** This should include showing them the structure of metric units, but a total education in the use of all metric units is not productive. Also, delay the actual training classes until just before the employee will be using metric units.

   Insist that all metric training be oriented to helping employees get a "feel" or mental image of the size of the metric units to be used. Do NOT teach employees to first visualize the inch-pound unit and then convert to the metric unit. This can lead to errors and a longer training span.

Some Suggested Steps to Take tn Metric Conversion Planning

The following steps may not apply to all companies. Select those applicable to your facility and tailor the actions to fit your needs.

1. Establish a (limited size) company metric advisory committee which meets regularly. It should generate the metrication plan, monitor the conversion progress, and prepare periodic reports for management.

2. Draft an overall company conversion plan, oriented to amortization of the cost of the changeover, via a gradual transition, taking advantage of obsolescence of equipment over several years.

3. Draft an activity breakdown, using the flow of the product through the plant; identify each department, section, or area, and list applicable tasks and estimated timing for task progress.

4. Using the overall conversion plan, draft a detailed plan for each department, section, or area. Include determining space for dual-stocking of parts and products.

5. Make a detailed checklist for use during the conversion period, and use it to note progress.

6. Check existing standards and specifications to determine how much revision or rewrite is required. This should include reviewing available government, ANSI, and ISO standards to determine whether it might be best to use them instead of rewriting company standards/specifications.

7. Alert vendors and suppliers of the date when the components they supply must be dimensioned to metric standards, and offer your help in vendor conversion to metric.

8. Begin an employee metric awareness program: place easy-to-assimilate data on metric units in the company newspaper, on bulletin boards; provide this data as handouts, and use other low-key training aids. [This is important because waiting to announce metric usage just before metric production begins could panic some employees who may feel their jobs are in jeopardy because they aren't proficient in metric system usage.]

   NOTE: A company's posting interesting and humorous posters regarding an upcoming planned metric transition often helps allay employee apprehension regarding the metric changeover.

9. Review the parts/components to be used in the company's metric production and select the preferred metric new sizes. [This is the time to examine all parts and components to ensure there is no proliferation in sizes or types.]

10. Investigate which equipment will need conversion. Often it is found that equipment will need only minor adjustments, modifications, or changes of gears/lead screws, etc. [One company found, during metric conversion, that several of its large machines were originally built in Europe to produce metric goods, and a conversion kit had been used to make them yield inch-pound products. Modification to remove the conversion kits was the only change required.]

11. Recalibrate or convert scales, measures, instruments.

12. Convert quality control procedures and equipment.

13. Convert process instructions.

14. Produce a metric drafting manual, and include:

    a. The company policy for whether dual-dimensioning will be allowed
    b. A dimension-rounding policy
    c. Establishment of a marking system to distinguish non-metric from metric items
    d. Instructions on how scaling will be handled on metric drawings

    NOTE: Dual-dimensioning on drawings is not recommended Because it is too easy for an employee to mistake a millimeter number for an inch number, resulting in costly errors. If it is decided that equivalent inch dimensions should be given on a drawing, a suggested method is to use only millimeter dimensions on the drawing and affix a table (generated via computer), that shows the drawing's millimeter dimensions and their inch equivalents.

15. Draft and issue a company SI metric practice guide, or adopt an existing guide and tailor it to fit your company's requirements.

16. Task the training department to purchase (or prepare) video tapes and reference materials for:

    a. The design staff and professionals
    b. The production personnel
    c. The sales/marketing staff
    d. The personnel that produce drawings and documentation
    e. Inspection and quality control personnel

17. Arrange to have marketing literature revised to show metric.

18. Set up a metric section in the company library and build the purchasing department's metric catalog library.

19. Check packaging and container/pallet requirements.

20. Prepare to issue metric tools (from the tool crib) to certain employees (such as machinists) who may complain that replacing their inch-pound tools with metric tools will be a financial burden. [Companies have found that, usually, these employees quickly find the means to purchase their own tools because they do not like to use company-issued tools.]

Guidance for Manufacturing and Metric Production

Companies involved in converting to production, using the metric system of measurement, will have to consider:

a. Producing components and parts to existing inch-pound designs, using new metric machine tools.

b. Producing metric components and parts on the company's existing inch-pound equipment.

Information on equipment/tools/instruments:

1. Two classes of equipment will not be affected by a changeover to metric system production:

   a. Tools and instruments that are not measurement-sensitive such as hammers, saws, shears, clamps, files, levels, and compasses

   b. Tools and instruments which are measurement-sensitive but will not change their units of measure:

      Electrical and electronic instruments and meters
      Tools and instruments which measure angles
      Timing devices and stroboscopes
      Event and revolution counters

2. Tools and instruments that will be affected by conversion to metric production include such items as drills, reamers, taps and dies, wrenches, micrometers, vernier calipers, height gages, radius gages, and thickness gages.

3. Certain tools can read both inches and millimeters, either alternatively or simultaneously. These include such tools as mechanical dual-readout micrometers (which may have a conventional readout in inches and a digital (counter-like) readout in millimeters). Electronic micrometers can be shifted from one system to the other merely by flipping a switch.

4. A few instruments may be converted from inch-pound readings to metric readings. These are the dial indicators with interchangeable dials and optical instruments which can be fitted with interchangeable reticles. Also, pan-type balances can be used to show ounces or grams by using applicable masspieces (what now are called weights).

5. Where metric holes and threads are specified, the company will have to acquire metric drills, taps, dies, and reamers. There is no commonality between inch-pound and metric taps and dies for either coarse or fine threads.

Care should be taken to mark the tools and instruments that handle only metric work. It could be costly if an employee uses a reading from a non-metric dial as the correct reading for a metric component . . . or an employee could damage metric screw heads by using an inch-pound system wrench on them.

Notes on Machine Tool Conversions

Feed Screws and Dials. This conversion may be handled by replacing the inch-reading indicator with one engraved in metric units; or the feed screw and nut assemblies of the machine can be replaced with units having the metric pitch.

If a machine is fairly new and has a considerable usage life, it may be worthwhile to replace the feed screws and nuts. If an older machine can be modified to an "as new" condition by a thorough overhaul, it also may be worthwhile to replace the feed screw assemblies at this time. The replacement parts could probably range from $200 to $400 per screw for most common sizes, and the machine could be out of action 3 or more days.

In larger machines, the cost of replacing a feed screw is likely to be high and the machine will be out of service for some time. In this case it might be better to consider modifying the feed screw indicator.

Converting of inch-reading feed screw indicators to metric readings may be accomplished by:

> Replacing the present indicator with a metric dial which gives the exact dimensional conversion.

Adding a metric dial alongside the existing inch dial and approximating how many millimeters will equal one revolution of the handwheel. This method of conversion normally is suitable only in those situations where the final dimensions of the workpiece are checked with gages or micrometers.

Installing dual-dial indicators, with internally geared drives that provide metric readings on one dial and inch readings on the other. These may be priced from $50 to $200 per unit (per axis), depending upon the complexity of the machine.

Digital Readout Equipment. Digital readout equipment is being increasingly used on machine tools for indicating the position of the cutting tool or the workpiece. This equipment will provide readout in either inch or metric units. The cost can range from $1000 to $2500 per axis and would cost more for larger machines.

Screw-Cutting Lathes. If a lathe is to be used for cutting both inch and metric threads, modifications to the screw-cutting facilities of the lathe are not advisable. Although lathes designed to inch standards can produce the more commonly used, fine-pitch metric threads as well as inch-pitch threads, the operator will find cutting fine-pitch threads on a machine with a metric lead-screw more difficult.

Numerically-Controlled (NC) Machine Tools. If purchasing a new machine, it is recommended that the company shop for one which features a suitable dual-unit control system. Converting an existing NC machine to work to the metric system units may be accomplished by replacing parts of the existing measuring and control system, but the cost will be high. A better solution is to carry out the conversion of the dimensional information at the programming stage. If control tapes are manually prepared, the conversion also will have to be done manually. Where the tapes are computer prepared, it is best to provide for conversion of the dimensions at some point in the sequence of the production of the tape.

Tool Holders. The design dimensions of a number of machines (such as milling machine tapers, morse tapers, and T-slots) have been internationally standardized to be identical in both inch and metric sizes. However, the user should be aware that problems might arise due to rounding off of dimensions to yield the metric sizes. This is important when considering which existing tools might be used on new machines or replacement tooling, for example:

a. With tooling of auxiliary equipment that is mounted via screw threads, such as lathe chucks and boring-bar insert tools, the thread onto which these items will be mounted should be specified when ordering replacement equipment.

b. With tooling that is mounted on arbors (milling cutters and hobs), the size of the arbors could be altered by the rounding-off dimensioning. Grinding wheels also should be ordered by the size of the mounting to be used.

Measuring Equipment. Metric micrometers, verniers, depth gages, scales, etc. should be readily available for employees to use. Most electronic and pneumatic gaging equipment provides size indications against a graduated scale, with both inch and metric graduations.

In Determining Equipment/Machinery Conversion: Examine all machinery thoroughly because a number of companies have found, during their metric conversion period, that some equipment was built overseas to yield metric dimensions and the equipment was modified to provide inch-pound system dimensions via addition of the conversion "black box." Reverting the machines to produce metric components required only replacement of the conversion kit.

Computer Operations

When planning to use metric on a computer system, identify potential problem areas by surveying day-to-day computer operations for isolating the items that will have to be changed or addressed.

Modify or re-design programs as required.

Prepare for additional storage requirements as a result of using two measurement systems (as you may be using both systems for a while).

Develop or purchase a good metric conversion program.

Adopt a project to identify the inch-pound and metric programs.

You also probably will have to modify the field sizes (or conversion parameters) to allow use of metric data because the metric terms and symbols (i.e., short forms) for metric units sometimes are longer than the terms and the abbreviations for inch-pound units.

NOTICE

To attain an efficient, economical changeover to metric system usage the transition to metric *must* be supported by the company's top management officials, who approve the conversion schedule and designate a top-level employee to monitor its progress.