OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

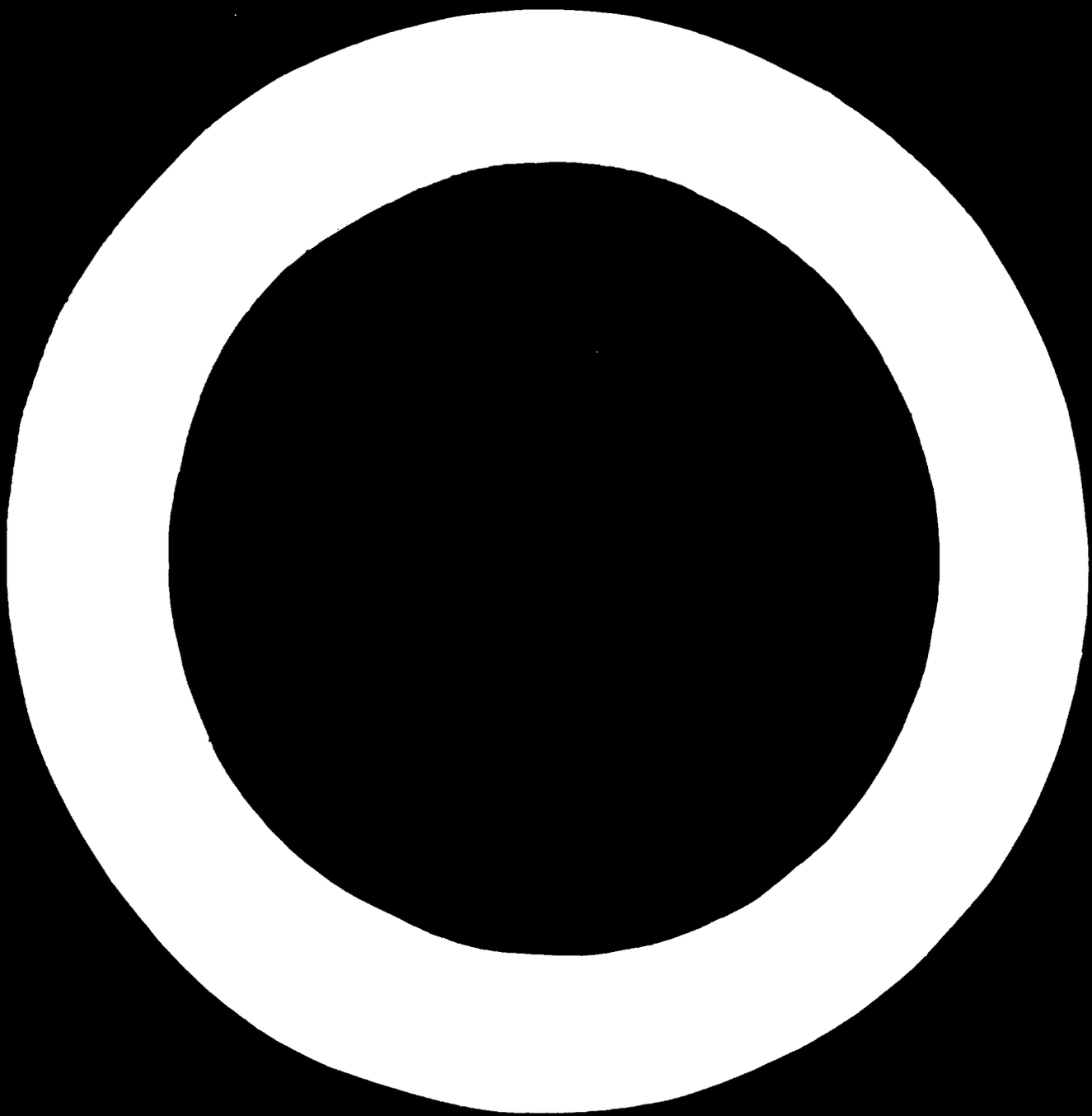
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

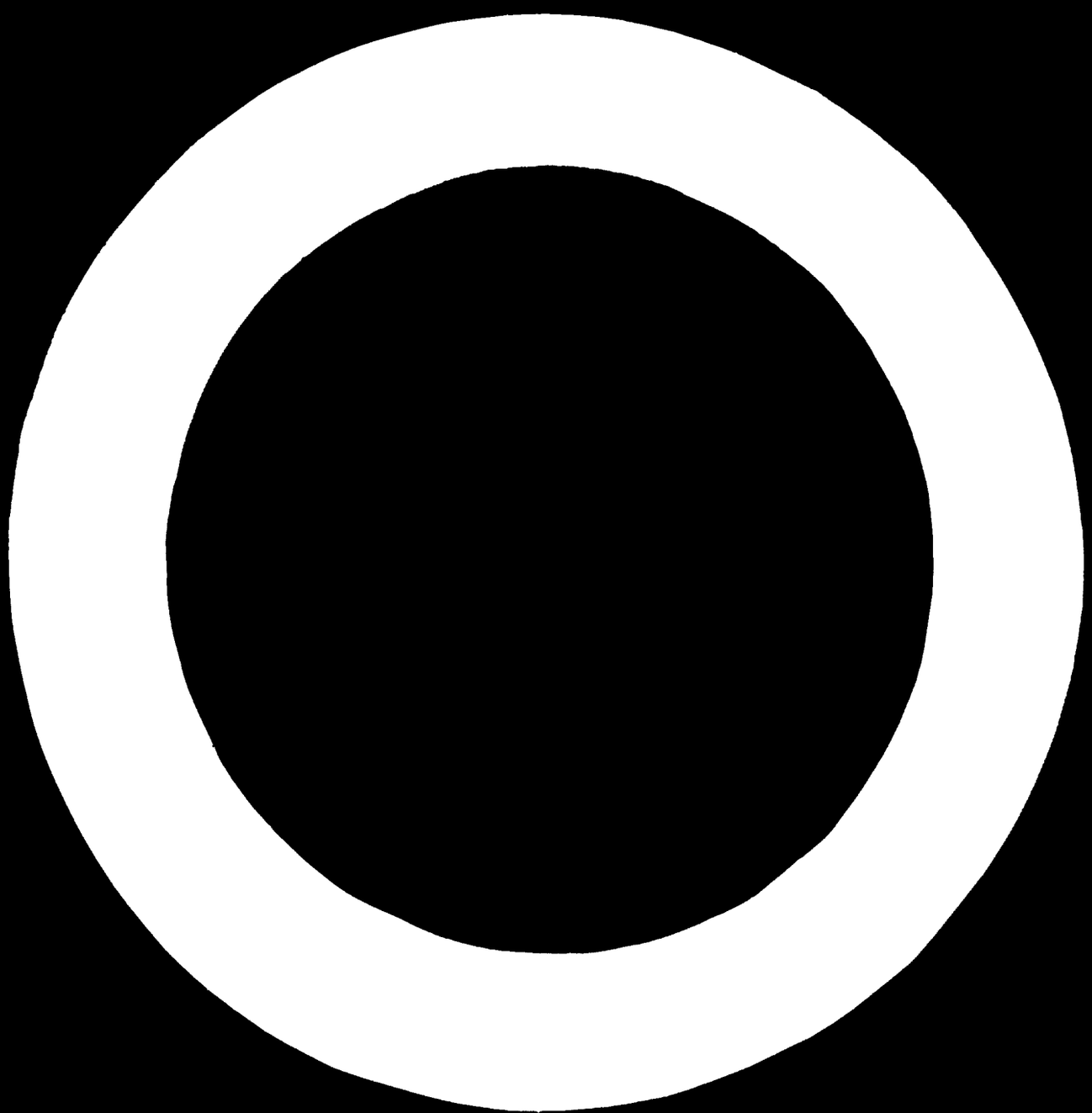
Development of Metalworking Industries in Developing Countries

Reports presented at the United Nations Interregional Symposium, Moscow 7 September—6 October 1966

Sales No.: E.69.II.B.2
ID/6

UNITED NATIONS
New York, 1969





D01378

THE PROBLEMS AND SIGNIFICANCE OF INDUSTRIAL STANDARDIZATION IN METALWORKING INDUSTRIES IN DEVELOPING COUNTRIES

John E. Wilson, Vice-president for Manufacturing, SCM Corporation

Industrial success in today's world demands careful planning and a broad knowledge of modern manufacturing techniques and practices. It is no longer enough to design a satisfactory product; the manufacturing process itself must be designed so that the product can be made economically enough to be competitive in world trade or locally. Industrial success, whether local or world-wide, is predicated on the capability to produce with economy, whether five or five thousand items are manufactured.

Integral to economical production is the implementation of a system of standards, particularly in the metalworking industry. These standards provide a common unit of reference that enables the industry to produce parts that are interchangeable, a necessity for efficient production, and enables more time to be devoted to creative efforts in determining new product applications.

When a designer can specify a type of screw, nut, or bolt by a number or letter designation that signifies its exact composition and dimensions, his time is then free for more exacting technical work. In one United States typewriter manufacturing plant, for example, the same screw is used forty-six times in one style of typewriter: the designers and production planners need only specify a number. Engineering time that might be spent on individual design for each screw is more appropriately spent on devising better designs and production methods.

By using a number of standardized parts in a product, production costs are kept to a minimum and maximum use is obtained for each part. If each of the forty-six screws in the example was of different design, production costs would be almost doubled. Materials can be purchased at lower costs when the quantity is increased, storage problems are minimized, similar machines can be used to produce the part and similar training can be given to machine operators.

The important role of standards in industry was expressed by Dickson Reck, editor of the book *National Standards in a Modern Economy*:[1]

> "The partnership between science and standards holds the secret to the extraordinary dynamism and productivity of modern industrial technology. This partnership begins at the laboratory door; it pervades all processes of production; it comes to rest only when the goods are used up in the hands of the ultimate consumer."

This paper examines this partnership and provides a knowledge of how standards can help any country in developing its metalworking industry. The paper describes the complex nature of standards and the means through which standards are developed and implemented, stressing the importance of a national set of standards as a necessary ingredient in a successful metalworking industry.

In addition, the paper summarizes the existing sources available to a developing country for use in preparing its own standards system, with the recommendation that this be done at an early date. Libraries throughout the world contain documentation of the standards experiences of other countries, published in several languages. Most of the national standards organizations already in existence provide material, on their experiences in implementing and devising standards, to other countries requesting it.

Some national governments also help developing countries in standardization. The Agency for International Development of the United States Government, for example, sends such aid to countries requesting it.

International organizations also provide assistance. The United Nations, sponsor of this and other symposia in industrialization, plans to increase its work in the field of standards. Plans call for expansion of research and information facilities and technical assistance through meetings, the establishment of standards institutes, the sponsoring of fellowships and assignment abroad of experts.

The United Nations also plans to work more closely with the International Organization for Standardization, a group of fifty-one nations whose co-operative work results in standards which may be used by all to facilitate international trade and to improve local production. Other regional groups, such as the Pan American Standards Committee and the European Committee on the Co-ordination of Standards, also facilitate the implementation of standards by a developing country. The results of the applications of standards to modern industry are thus readily available to developing countries.

The necessity of standards in industry is widely accepted today, after decades of experience. Standards, however, have long been prevalent in all forms of social relationships, much longer, in fact, than they have been used in industrial production.

[1] Reck, Dickson. *National Standards in a Modern Economy* (New York: Harper Brothers, 1956), p. 9.

They are so interwoven in the daily pattern of life that they are sometimes difficult to recognize. Language itself is a type of standard. The words defined in a dictionary must be combined in patterns that are recognizable in order to convey a thought. Without accepted standardization of these patterns, their meanings would not be understood.

Standards of measurement have been used since Man found it necessary to calculate dimensions and distances. At first, the standards consisted of the natural elements, but as civilization became more sophisticated, standards did also. There was no need in antiquity for a standard specifying the number of inches in a foot or centimetres in a metre, but this is a requisite of a modern industrial age.

Standards thus are necessary in all phases of life as models or examples. Their application to modern industry is particularly crucial for, in industry, they represent solutions to problems which continually reoccur. Modern industrial standards provide a guide for design, manufacture, and use of an item by stating specific requirements for acceptability and implementation. Standards describe the item or an action pertaining to it in such a way that misunderstanding is not possible. In addition, a measuring method for conformation is an integral part of the standard.

Standards are written to provide consistency and uniformity for any item at any stage of production, as raw material or as a finished product, and can describe any process involved in production or use. Since standards are essential to producing identical parts that can be interchanged, they are essential to modern metalworking industries which convert metallic materials into parts or products. The artisan who made bows and arrows did not have to be concerned with keeping each set he made consistently uniform, but the factory that manufactures typewriter parts today must ensure that each part of a certain kind is uniform and can be used in place of another like it – a task that can be accomplished only if standards are maintained to measure the uniformity.

Industrial standards may be established to encompass a company, an industry, a nation or even a group of nations. Regardless of the intended scope, those standards whose impact in a country is more than company-wide should be co-ordinated through a national standards organization. Also, it is through national standards bodies that representation in international standards organizations is effected.

Much can be gained from a thorough study of the standards systems in effect in the older, more developed countries and of those that result from the work of international groups. These systems took much time to develop and, although certain national specifics must be considered, the developing country can benefit by adapting these standards.

The importance of the early implementation of a standards system cannot be overemphasized. In some cases, an agreement on a standard method is a necessity before industrial development can begin, let alone progress. Standards for a measurement system and electrical power, for instance, must be in use before an industry can flourish and survive in today's complex and competitive commercial environment.

How standards are made

The establishment of a standard, whether it be for use in the metalworking industry or another, may be effected through voluntary or compulsory methods. When a voluntary standard is enacted, a manufacturer may decide whether it is in his best interests to use it, determining whether the standard is compatible with his production methods or whether it is not. These standards are usually produced by a body of representatives of trade associations, user groups, engineering societies and the like, on a national, industrial or international level. A compulsory standard, on the other hand, is usually produced by a political or governmental group such as a legislative or administrative body; laws or other regulations mandate using the standard and often impose punishment for not using it.

It is through the employment of a flexible standards system that considers the views and ideas of all concerned that the United States economy and others like it have achieved industrial success. Views are not frustrated by legislative entanglement and the dictates of a small political group; rather, they are accelerated by the free interchange of ideas. In much the same way as information is exchanged at international meetings, the voluntary means of producing standards bring representatives from all groups concerned about a problem together to find an effective solution. All aspects of the problem are considered and a solution that brings each aspect into proper focus results in better products for the consumer at lower costs.

However, the exclusive use of either the voluntary or the compulsory method of standardization does not provide results as effective as does a combination. Voluntary standards stimulate the production of better, less expensive goods for internal and external trade. Compulsory standards, however, provide the best means for regulating facets of manufacturing that concern safety or general public welfare.

In the United States, for example, an existing voluntary standard provides a series of guidelines and rules for industries that want to avoid fractions and use decimals. Those manufacturers that see disadvantages in changing from one system to the other have the choice of not using the standard; however, those who feel the advantages outweigh the disadvantages are provided with a uniform system that has been given careful and thorough consideration. Since this matter does not concern the general public, industries themselves can best determine whether it is to their advantage to implement the standard or whether implementation would increase their production costs too greatly and thus increase the consumer price.

On the other hand, members of the metalworking industry in the United States are bound, by state and federal laws, to provide certain safety features for employees. In most states, for example, the law stipulates that power presses for trimming, forming, stamping or assembling metals must be equipped with guards that

keep the operator's fingers out of a danger zone when the press is in operation. These guards may actually enclose the area in which the punch press moves downwards to form the metal or they may provide some means for moving the operator's hands out of the way.

One type of guard actually sweeps the operator's hands away if they are in the path of the ram of the press as it comes down. Another pulls the operator's hands back if they are in the danger zone. A nylon band connected by a cable to the ram of the press is worn by the operator. If he does not remove his hands before the press begins its downward movement, the cables automatically pull his hands back out of the way. Some machines must be equipped with a switch that requires the simultaneous action of both the operator's hands to activate the press. On others, foot treadles that activate the press must be shielded so that they cannot be accidentally struck. In these instances safety, not cost, is the prime consideration and the manufacturer has no choice but to implement the standards.

However, the intent of the law is to safeguard employees, not to handicap the manufacturer by requiring unreasonable expenses for safety mechanisms. Thus, if a law stipulates a certain type of guard and a manufacturer feels that another type would be better, he usually may apply to change the prescribed procedure.

Standards may also be prepared by company management for use within a single company. They standardize methods which have only an internal effect; that is, they make the company's production more efficient. These company standards should always be compatible with existing national and international standards to provide a consistent approach and to make the product as marketable as possible.

Voluntary standards

Voluntary standards usually arise because a group with common interests is able to see that economies, higher quality products, or both can result from adoption of a standard procedure or part. Standardization of certain parts, for example, results in a substantial reduction in inventory and thus effects a reduction in operation costs; commonly used parts do not have to be designed again and again. The resultant economies enable the sale of an item at a more competitive price, and thus make the standard more appealing to the producer.

Moreover, because standards set up only minimum qualifications for a product, they encourage the manufacture of better products. When most manufacturers in an industry agree to conform to certain minimum standards, those whose products do not measure up to these standards will not have consumer acceptance. In addition, manufacturers will be motivated to improve their products beyond the minimum standards in efforts to capture more of the consumer market. When more than one manufacturer produces a product, the consumer compares the qualities and prices of the products before buying. If the consumer can obtain a higher quality product at a comparable price, it is natural that he will choose the better product. Since the manufacturer tries to provide the consumer with what he wants, it follows that better goods will be continually produced.

Sometimes, too, safety acts as motivation for voluntarily establishing a standard. The standard in the United States that provides a numbered identification system for outlet and inlet systems for compressed gas cylinders is an example. Originally a voluntary standard, but now incorporated in many state laws, this safety method involves a relatively simple mechanical device that prevents inadvertent mixing of gases. A number value is assigned for use with a specific gas. A cylinder containing one gas cannot be connected to a line meant for another since each gas has a separate type of connexion. External and internal threads, right-hand and left-hand threads as well as threads of different sizes prevent interchangeability. Because the standard is generally used throughout the industry, a manufacturer can obtain the gas he needs, confident that it is compatible with the connexions already in use in his factory.

Once the need for a standard has been agreed upon, a draft is formulated by a committee of representatives from all of the groups concerned: leaders in design, manufacture, and use. This committee determines what the standard should accomplish, what industrial and geographical areas would be involved, and what conflicting interests and requirements are to be considered. A careful balance between divergent factions should be maintained on the committee for the establishment of a standard that is most effective.

A subcommittee then prepares a draft of the standard and submits it to the committee for comment. Revisions are made and considered, and the revised draft is sent to a broad group of interested individuals and organizations. The committee considers all comments received, making changes in the draft where needed, before voting on a final draft. If approved, this draft would be adopted and made available for implementation. (A detailed explanation of committee workings in a specific voluntary standards organization is in pamphlet PR-27, "The Organization and Work of Sectional Committees Operating under the Constitution, By-Laws, and Procedure of the American Standards Association", available through the American Standards Association, 10 East 40th Street, New York, New York 10016.)

There are some cases in which a voluntary standard may be prepared by a government agency. Because of its unique position, a government may perceive the need for a standard before the industries concerned do or may even be requested by an industry to provide a standard. A period of research and orientation would then ensue in which a competent government engineer familiarizes himself with the situation. He may arrange personal consultations with product producers and users, or he may confer with them by telephone or mail. Once sufficient data has been compiled, he prepares a draft of the standard which is distributed to as many concerned parties as practical for criticism and comment.

In order to make the final draft as universally acceptable as possible, all comments are thoroughly and carefully reviewed. Changes that improve the standard are made in the draft which is again sent out for review

and comments. The procedure is repeated until substantial agreement is attained. When a standard is final, it is issued as a government document that may be used by manufacturers.

The group originating a voluntary standard should retain responsibility for it. Periodically, it should be reviewed and changes to keep it up-to-date should be recommended. It might seem that continually revising a standard would impose undue difficulties on the manufacturers, but the experience in the United States has shown that this reviewing and updating actually bring the manufactured object closer and closer to the consumer's ideal. As producers continually improve their product to meet competition, higher requirements in approved standards are compatible with their own facilities.

If changes are necessary to keep the standard consistent with technological, sociological, or other advances, they must be made. Since the manufacturer is constantly improving his product to meet consumer demands, a standard becomes virtually useless if it does not keep pace. Information gained from the practical use of the standard is also of importance in determining changes. Some part of a standard may have appeared usable while it was being written, but field experience may prove otherwise.

When voluntary standards are as successful as they are in the United States, certain conditions must exist. Since adherence is nonobligatory, the standards must be acceptable to many different groups. This necessitates the inclusion of compromises between conflicting desires so that the standard can be widely used. All major interests must be given the opportunity to help in preparing the standard. Even a single negative vote in the balloting for adoption must be given careful consideration and must result in action acceptable to all members of the committee.

In many countries the United States for one—groups issuing voluntary standards must ensure that they conform to existing laws. For example, voluntary standards in the United States must not be adopted which act in restraint of trade. Manufacturers must not conspire to fix prices, for instance, since this would be unfair to those not included. In other countries, however, such practices are within the limits of the law and are even encouraged. Giant steel cartels are legal in Europe, prohibited in the United States.

It is important, too, that producer and consumer interests are balanced when a voluntary standard is established. The producer wants to keep costs down and sell his goods at the highest prices they can command. The less it costs him to produce an item and the more he sells it for, the greater his profits will be, whether he receives them in monetary form or whether he receives more or better goods through bartering. The consumer, on the other hand, wants high quality goods as cheap as possible. Since the standard provides minimum requirements, the views of both must be reconciled for optimum effectiveness.

The means by which voluntary standards are produced provides a distinct advantage. Because so many interests must be consulted and because all are considered, the standard that is issued is generally more usable and practical than if just one group or agency was responsible for the formulation. There is, in a way, a cross-fertilization of ideas that results in a more complete document. Pooling their ideas, many leaders can formulate a better standard than just one working alone. Often more ideas result when several people meet together. Individual ideas are mutually shared and used, and the proposals by one sometimes trigger new ideas from someone else. The very fact of meeting and discussing a problem together acts as a catalyst for new ideas.

The fact that so many are involved in the production of a standard also means that a selfish proposal has little chance of adoption. A political group, for example, which desired a standard to promote its own interests would be foiled unless the standard had universal merit; only those standards which are truly desired and needed will be adopted.

Since voluntary standards usually arise, in part at least, from manufacturers and those most knowledgeable in the area of technological advances, little time will be lost in updating.

Voluntary standards in no way restrict the adoption of laws to protect public health, safety, and welfare. If a government feels that a voluntary standard does not have enough safety features, it can mandate a standard that does. Likewise, if a private group feels that a governmental standard is not strong enough, it can adopt a stronger one.

Because private manufacturers produce voluntary standards, their businesses remain less affected by government restrictions and controls and, in effect, regulate themselves. New ideas are encouraged and can be quickly implemented when governmental machinery does not have to be activated.

Progress can be accomplished more rapidly in a nonrestrictive environment. The phenomenal achievements made by Japanese industry in such a situation are proof of this. The slow legislative proceedings that institute compulsory standards often hinder a manufacturer. His methods of production are tightly regulated through centralized control. If he wishes to deviate from the prescribed method, a complex legislative procedure must be followed. Knowing this, his incentive for implementing new and better procedures diminishes.

Despite the advantages that diverse interests provide in standard making, certain disadvantages also are inherent. A variety of groups naturally will have a variety of opinions, making a consensus difficult. It has already been noted that the committee promulgating a voluntary standard considers all criticisms and comments. When negative viewpoints persist even after revisions have been made, issuance of the standard will be delayed. A manufacturer, for example, might feel that he must divulge trade or company secrets to release enough information to prepare a standard. Or he may feel that the standard would require quality that would be overlooked by the consumer and thus would not justify higher production costs.

Sometimes a standard will be delayed because a manufacturer feels that advances are being made so fast

that the standard will become obsolete before or soon after it is issued. It should be emphasized, however, that voluntary standards are not binding; the manufacturer can offer more than the standard requires, and the consumer can demand more. Voluntary standards are thus less limiting and more adaptable to specific needs.

Since voluntary standards involve compromises, it is doubtful that the perfect standard from both consumer and producer viewpoints could be formulated. Some consumers, for example, might desire a feature that the producer felt added too much to the manufacturing cost. A compromise would have to be reached. The power of public opinion, however, cannot be overlooked. If enough consumers want added quality in the form of extra features, producers would have to yield in some way. Often, several lines of value will be offered. In the automobile industry, for example, it is a common practice to produce several variations of a specific car: some offer merely basic transportation—while others provide added features.

Compromises are also necessary when two or more producers or two or more consumers have differing views. A standard involving "deep-drawing" steel, for example, would have to be acceptable to all users of such steel, whether manufacturers of automobiles, truck bodies or house trailers. The voluntary standard therefore, embodies a usable plan rather than a theoretically perfect one.

Compulsory standards

Implementation of a compulsory standard is mandatory. Neither manufacturing nor consumer interests are given the choice of whether to adhere to the standard. On a national or State level, these standards are usually issued as laws, or as regulations based on laws, and disciplinary action can be taken if they are not used as and when prescribed.

Compulsory standards are usually created by a governing political body or some regulatory group functioning under authority of a law or edict issued by the political body. The standard may be written by an individual or committee appointed by the political body or even by the political body as a whole. Producer and consumer groups concerned may not be consulted and criticisms or comments do not have to be considered. The standards, thus, might not allow for varying interests.

When compulsory standards are used in all areas, they tend to limit innovations. The legislative process is slower than the voluntary and can deter the implementation of better, more efficient standards. Moreover, a governmental group cannot be as knowledgeable about manufacturing techniques as manufacturers themselves; since it is not directly involved in production, a government cannot be aware of all production complexities.

However, compulsory standards have great value for safeguarding the health, safety, and welfare of the public. It is in the best interests of the public, for example, if there is no option allowed for a manufacturer to ignore a standard that establishes the number of emergency fire exits in a building.

In the United States, many safety standards are issued as regulations by agencies established by law which are specifically given the authority to direct operations in a certain area; the Atomic Energy Commission and the Federal Aviation Agency are examples. The Federal Aviation Agency, among other duties, limits the number of hours a pilot can fly.

Numerous local governmental groups are also in operation to set up local regulations. In Los Angeles, California, certain types of products may not be sold unless they meet specified safety requirements. Electrical products, for instance, must be certified that they have been tested for safe operation.

The very basic standard designating systems of measurement is compulsory in most countries. Only confusion could result if there would be no common agreement on the meaning of measurement terms. By standardizing the exact unit of measurement, the government ensures that it has a common meaning whenever it is used.

How Standards Are Used in the Metalworking Industry

The importance and use of both voluntary and compulsory standards in the metalworking industry is broad and basic, encompassing not only the actual production phases, but also the planning and construction that must precede.

Company standards for internal use enable common references by all departments and facilitate production procedures by eliminating misunderstandings. Standards for use throughout the metal-working industry provide a means for maintaining quality products and encouraging continued product improvement. Moreover, individual companies can benefit from sharing common experiences and jointly solving common problems. National standards provide for common solving of problems that are not peculiar to a single company or industry. Formulating such standards means that an orderly approach to basic issues can be taken. International standards, likewise, provide a basis for trade between countries.

All four levels of standardization –company, industrial, national and international—contribute much to the development of a metalworking industry.

The extent of standards usage in each area, of course, is predicated on the degree of sophistication and development of the country and the industry. Although total standardization might not be required in the beginning, knowledge of it can facilitate planning for when it will be necessary.

Plant construction

In the United States and in many other countries, State or local laws set requirements for permissible building occupancy; size, location and number of exits; stairwell; fireproofing; exhaust systems; etc.

Without such standards, individual companies would have to design factories incorporating safety features which might or might not be adequate. A tragic occurrence in New York City some fifty years ago led to mandatory State safety standards for fire exits. At that

time, a fire in a building in the garment district resulted in many deaths when inadequate exits prevented many of the workers from escaping. Had safety standards been in force at that time, the tragedy could have been avoided.

National electrical standards are extremely important to an industrial nation. Without a uniform system of establishing and using power sources, the task of developing industry is greatly hindered. Likewise, adherence to standards when installing the electrical system of a new factory is essential if the factory is to be able to use the power.

In addition, standards for proper lighting for particular kinds of factory operations facilitate planning and ensure that an employee has sufficient light to perform a task. Emergency lighting procedures should also he considered.

State and national standards regulate certain plumbing facilities, detailing minimum requirements for size and location of rest rooms, screening of exits, washing facilities, and the like. These, of course, must he considered in factory construction. Again, the existence of broad requirements on a national or industrial level facilitates construction planning and ensures at least minimum requirements.

The problem of waste disposal and sewage treatment grows as industrializatio n increases, and often becomes almost impossible to solve if it reaches serious proportions. National, state, or local standards regulating this phase of industry should be given careful consideration at an early phase of industrial development. Experience in the more developed countries has shown that the time to act on industrial pollution is before it begins. Specified limits and procedures should be agreed upon before pollution becomes a serious problem.

Standards for testing water purity can ensure that enough safe water exists at a proposed site for normal supply requirements and for a reserve supply for fire protection.

Although standards do not usually mandate the temperatures to be maintained by heating and cooling systems, standard practices should be kept in mind when designing the systems. For example, in the United States, northern factories are heated to 72 F., and southern factories are air-conditioned to about the same temperature. In English factories, however, the custom is to heat to 60 F. Heating and cooling thus must be suited to local practices.

Plant equipment

Machine tools selected for the metalworking industry should be built under a standards programme to restrict machine varieties to as few as possible. Investment in the toolroom and production areas is thus decreased, setting up the plant is more convenient and maintenance is easier since fewer kinds of replacement parts are required. Machine tools should be purchased only if they accept standard spindles, tapers, chucks, taps, and dies. Safety standards mandated by state or local governments and used by the equipment builder ensure maximum operator protection. Standards for placement of equipment ensure correct spacing and aisle widths.

Production tooling

Whenever possible, tool designers should make use of standard items such as die sets, dowel pins, nuts, bolts, drill bushings, drills, reamers and cutting tools. This cuts time and money for special designs each time the part is to be used. It is much more expedient to agree upon uniformity in commonly used items and to document the agreement for additional uses. A screw, for instance, can be designated by a series of numbers and letters that indicate all its specific characteristics to anyone who knows the standard. Using a standard item thus frees the tool designer for work on improving tooling equipment and its uses.

Using standardized steel in tool designing ensures uniform machining and heat treating results regardless of the supplier. A standard grade of steel is also less expensive to use, since a steel company can depend upon greater quantity sales and thus produce at a reduced unit cost. Inventory expenses are also reduced since fewer types must be stocked.

Product engineering

Standards facilitate product engineering in the areas of product development, manufacturing drawings, patents, and testing. Product development engineering must take into account product standards established by industries, customer requirements, recognized testing laboratories, and state and federal laws.

Industry-wide consensus is sometimes a prerequisite for product development and design. The United States television industry, for example, found it necessary to agree on standards for frequency, number of frames per second, number of lines per frame, degree of definition and other technical matters before it could present the product to the consumer. This ensured that all receivers regardless of the manufacturer would receive television images from any transmitters built hy any manufacturer. Without this standardization, television could not have begun as a commercial enterprise.

Another example illustrates the advantage of early standardization by showing what happens without planning. In 1875, Sholes, Glidden and Densmore, inventors of the lirst successful typewriter, conceived the keyboard arrangement that is still in common use for the English language. Although their design was based on the frequency of letter usage and the most common character sequences, it gave little if any attention to the arrangement that would provide maximum ease, speed of operation and even loading for the two hands. They made a list of the frequency of juxtaposition with which letters in the language occurred, and the letters which occurred together most frequently were placed as far apart as possible to eliminate key jamming.

For the next ninety years, there were many suggestions for a new keyboard: double keyboards, the arcuate keyboard, the six-row keyboard, the "ideal" keyboard of 1890–1900, the Dvorak keyboard of 1935–1945, and others. In the latter period, serious attention was given to keyboard arrangement from the standpoint of ease and speed of operation. By then, however, it was im-

possible to effect a change. So the basic typewriter keyboard for the English language is still the straight-row keyboard developed by Sholes almost a century ago. If the policy of standardization by consensus had been known and used then, a more efficient typewriter keyboard would have resulted.

Standards must be carefully considered in the development of electrically powered products. Appropriate changes must be made for domestic and foreign markets allowing for variances in voltages and power outlets. National standards of measurement are also important in the design and calibration of machine tools. A dial calibrated for inches, for example, would have little use if the basic national standard was of a different system.

The development engineer should be trained to make maximum use of standard stock parts, such as screws, nuts, rivets, and ball, roller, and plain bearings, to get maximum use of time, money and materials. For the same reasons, he should use materials that have been manufactured to standards regulating physical properties such as thickness, hardness, and composition. Reducing the total kinds of parts means, too, that replacement parts can be stocked easily throughout a country.

Development engineering must provide for interchangeability by establishing the proper tolerances and specifications for use in manufacturing. The practice of tolerances is well established and is used in accordance with product requirements to maintain interchangeability, quality performance, long life and reliability.

Manufacturing drawings are the communications medium for the metalworking engineering department. The drawings convey detailed specifications such as heat treating, plating, polishing and painting and include special instruction for adjusting, testing, etc. Drawings must be understood easily, completely and uniformly expressed, and as brief as possible. Drawing standards ensure this by setting up a uniform system of drawing sizes, line conventions, lettering, scale, projection, dimensioning, tolerances, surface finish, etc. Preparation of basic drafting standards by the national standards group can smooth the standardization process of companies and industries.

Patent applications and drawings should conform to standard practices regulating format and processing. These standards are often compulsory and are usually issued by governmental sources. In the United States, the Department of Commerce through its Patent Office is the source of patent procedures. If applications are made in other countries which participate in the International Patent Convention, they must be processed according to procedures established by the convention.

In some countries, national or private laboratories test products for performance against established standards. Acceptance by the laboratories assures the customer that the product has passed certain safety and reliability tests. Approved by these laboratories is accepted in some instances instead of approval by local inspectors. An example in the United States is the Underwriters Laboratories which tests electrical products for safety. Although this is a privately operated testing facility, its approval is accepted in all areas in the United States. A similar organization is the Canadian Standards Association which oversees electrical installations and safety features of electrical equipment throughout Canada.

Manufacturing

Almost two centuries ago, the application of interchangeable parts manufacture revolutionized manufacturing practices. About 1800, Eli Whitney, a famed American inventor, began manufacturing muskets for the Government so that the parts could be used interchangeably. Until that time, products were individually made and repair parts had to be specially fitted.

The benefits of interchangeability, however, are lost without the use of standards to measure component uniformity. Standards, in fact, make interchangeability possible. Today, the application of tolerance standards establishing allowable variations is a prime requirement in all companies in the metalworking industry. Tolerances are selected to provide a given function at the proper cost, performance and reliability. Most tolerance standards are established by the individual company to suit a particular product. Generally, the wider the tolerance the less expensive the product; the closer the tolerance the more precise the product and the higher the cost.

Tolerance standards coupled with modern processes and equipment are the basic requirements for low-cost mass production. As an example, the cost of a manual portable typewriter made by hand by skilled mechanics in a model room would be approximately $16,000. After high production tooling and the use of standards, however, the same machine in volume production would cost less than $50.

Work standards in manufacturing engineering establish the time standard for all operations and the method for performing each operation. Adjustment and inspection operations must also be standardized.

Manufacturing specifications detailing these requirements should be expressed briefly and simply, but should be complete and to the point. These specifications protect all concerned: they give management the desired product at the proper cost and protect the workman from unjust criticism if he has followed the specifications.

Purchasing

Purchasing is no longer just a matter of placing an order for goods. A request for three tons of steel means little to a supplier without an exact description of the desired composition, strength, etc. No manufacturer can succeed unless he can be assured of the raw materials he needs at a price that will allow him to produce at a profit. If the materials are of higher quality or of closer tolerances than needed, production costs will rise. If they are of lower quality, product quality will suffer because of frequent breakdowns and repairs.

Using a standard not only results in the acquisition of the right materials, but also in saving time, since the next time the goods are purchased the standard can be used again. Consistency is maintained, and a new description does not have to be prepared.

When a company adopts a standard stock catalogue from which basic supplies are ordered, company decisions are co-ordinated and simplified. Lower inventories result, since fewer kinds of parts are needed and goods can be purchased at the lower rates for quantity buying. Maintenance is simpler, inspection easier and workmanship better. One company, for instance, purchases one type of cold-rolled steel from which it makes almost eighty different parts. The characteristics of the steel are thoroughly known and fewer types of machines are required to manufacture the parts.

Large quantity purchasing helps not only the manufacturer but also his supplier who can produce more and sell at lower costs.

Similar savings can be effected through an industry-wide purchasing standard. For example, United States oil companies were plagued with a common problem involving the purchasing of underground gasolene tanks for use by service stations. Each company had its own type of tank. A meeting involving representatives from all concerned resulted in an agreement on a standard underground tank, thus benefiting both purchaser and supplier.

National standards in purchasing have increased in importance and acceptance as industrial technology has increased. Use of a national standard which is revised periodically can often effect a savings. In one instance, a company discovered that its own internal specifications for steel purchasing were not only outdated but were increasing costs by calling for a type of steel processing no longer in common use. The specification had been valid and even necessary years before, but had no application in modern industry. Adopting an existing national standard resulted in immediate savings.

Production and inventory controls

There are many standard procedures by which a metalworking company can control procurement of materials, manufacture or purchase of parts and production of final units. The procedures depend on the volume of material, parts and units required in a given time. Low-volume production can be handled with a few simple controls, while high-volume production requires sophisticated controls.

A simple system would include such information as lot sizes, reorder points and inventory records. A lot size is the amount of material or parts manufactured or purchased in one order. The size of the lot is established after study of the unit cost, monthly usage and time required to make or buy.

A reorder point is the minimum quantity of material or parts on hand at the time of a replacement order. Reorder points are based on rate of usage and time required to obtain the next order.

Inventory records are maintained showing orders received, withdrawals, and current inventory for all parts, supplies—and raw materials.

Control of product quality

At each phase of the manufacturing process, product quality must be carefully checked, a task that can be accomplished only if a basis for evaluation in the form of standards has been documented and agreed upon. This control begins with purchasing of raw materials and continues to a final check of the finished product.

Like all standards, those in purchasing include a means by which incoming goods can be evaluated for acceptability. In the production phase, when raw materials are converted to finished goods, quality standards again provide a means for measuring the goods against an acceptable norm. It should be noted that the standards for quality in manufacturing are somewhat flexible; they allow for some deviation from the tolerances specified in the standard when it is wholly impractical to do otherwise.

The standards for manufacturing product components are generally set a bit higher than really needed to maintain the desired quality of the finished product. Thus, some leeway is allowed to accommodate production problems, and a set procedure is generally established through which all those concerned are notified, in writing, of the plan to deviate from the standard.

Because of these provisions for variances, the standard allows some creativity in the production process. A new way can be tried as an experiment and if it proves feasible and more practical it can be implemented by revising the standard.

Standards must also be used to sample the finished product to ensure that the desired quality is met and that the product performs as desired. Again, certain tolerances should be allowable to provide for the proper balance between the perfect product that the sales unit might desire, and the need for expediting production to keep manufacturing costs at a minimum. Safety features, product use, the cost of replacing parts whose performance is guaranteed, and many other considerations must be made to arrive at a suitable product quality.

Product testing must be performed under conditions comparable to those under which the item is designed to function. A product to be used on a boat, for example, should be tested in a marine environment.

Since it is usually impracticable to test each article, a method must be defined for selecting test specimens. Special care must be taken that the sample is truly representative of the final product. Some raw materials, for example, are purchased in bulk lots and vary in quality at different points in the lots. The test specimen must be made up of a combination of raw materials taken from various parts of the lot purchased.

The role of statistical analyses in selecting test specimens should be carefully considered. Many textbooks explain this concept in detail; in addition, the American Society for Testing and Materials has available several booklets on sampling and probability.

Personnel administration

Personnel administration in metalworking industries includes several responsibilities that make use of established national, industrial and company standards. National and local safety standards apply to guarding machines, plant housekeeping, elevator designs, stairwells, exits, fire hazards, fire alarm and sprinkler systems, ventilating systems, water supply etc.

In larger manufacturing operations, company standards are established for wage and salary administrations. In general, they include job descriptions, job evaluations, labour grades and wages or salaries.

Labour standards are usually established for different jobs by national or local regulation or by the individual company.

It is the responsibility of the medical department to measure the physical fitness of new employees in a company against established standards, to make periodic examinations when required by law and to provide medical attention.

Cost accounting

Company standards are used in factory accounting for controlling and measuring the manufacturing operation. A standard cost representing an estimate of the total cost of producing an item is established before production is begun. Once the item is manufactured, the estimate is compared with the actual cost to determine whether the production is profitable.

An annual operating budget to plan company financing provides a similar measurement for the operation of the company as a whole. Expenses for salaries, supplies, taxes, telephone, rent, etc., are estimated for a yearly period. Later, the actual cost of each item is compared with the budget to determine efficiency.

In addition, factory accounting establishes standard procedures for inventory and operating records. Other audits include accounts payable, payrolls, fixed assets, and expense items.

Problems of the developing countries

The problem of standardization in the metalworking industries of developing countries is part of the over-all process of industrialization that is often stymied by the political, economic and social environments. Fundamentals such as national language, resources, and technological experience are sometimes not as sophisticated in a developing country as modern technology requires. The obstacles, however, are not dissimilar to those that have faced other nations at similar stages in their development. Once the problems have been identified, the approaches to solving them can be illumined by the experiences of other countries.

The description of standards usage in modern metalworking industries shows that much experience is required to analyse technological areas for standards application. Experience indicates areas in which standardization is an impediment rather than an aid and those in which standardization is permissible but not required. The pace required for industrial success leaves little time for a developing country to develop this experience as some of the older countries did through decades of industrial evolution. Other sources must be consulted if industry is to be developed fast enough to take a prominent place in the industrial world.

The limited number of skilled technicians in developing countries is a handicap in producing a standards programme. However, international assistance is readily available.

National vocabularies of developing countries are often not adequate to express accurately the complex ideas involved in standards. Even more highly developed countries sometimes have difficulty writing standards that are completely accurate and understandable. Interpretation problems could defeat one of the prime purposes of a standard: to ensure uniformity. Special care must be taken to make standards conform despite language inadequacies.

The limited extent to which developing countries have participated in international commerce is a disadvantage in implementing their own standards. Through wide participation, a knowledge of standards use in other countries is obtained as well as an appreciation of the importance of standards to both buyer and seller. This knowledge is beneficial in preparing internal standards and is essential in arranging trade with other countries.

Because metalworking industries are only minimally developed in many countries, widespread support for a national standards programme is often hard to obtain.

Careful analysis will ensure that the standards programme is compatible with the degree of industrial development. It would be foolish for a country to accept standards that are beyond the capabilities of an infant industry; this would only further deter acceptance. Once a proper evaluation has been made, convincing others will be easier.

The information in the following section outlines the sources from which the developing countries can obtain assistance in preparing a standards programme that will benefit metalworking industries.

What is available to the developing countries?

Formulating industrial metalworking standards is a formidable job for developing countries, but one that becomes easier with the availability of existing standards which can be adapted. Almost all of the standards experience of the world is available to the developing nations. This experience is documented in thousands of published standards in several languages and in numerous technical works, from short papers to books.

The developing countries may procure standards from national standards organizations in many other countries. The American Standards Association automatically sends copies of American standards to more than 160 standards groups in other countries.

The United Nations, through its symposia, is another source of standards assistance. By bringing countries which have established standards systems together with those which do not and by providing a wealth of technical information at these meetings, the United Nations emphasizes the importance of standardization and stimulates the creation of national systems. The proceedings and recommendations of United Nations meetings are readily available in several languages, as are a great number of its other publications dealing with industrialization. For example, a series of manuals, containing technical information about the establishment of new industrial projects has, been prepared.

The United Nations Industrial Development Organiza-

tion is responsible for United Nations activities in standardization. Besides giving technical assistance through meetings and seminars, United Nations aid includes helping establish standardization institutes throughout the world. The Technical Standards National Institute in Paraguay, for example, prepares standards and research dealing with quality in products. Its services are available to the governments and industries of developing countries.

Through the United Nations, some twenty countries in recent years have received assistance through studies made by United Nations experts. The reports from the experts are transmitted through the United Nations.

Training and fellowship programmes in standardization and quality control are also sponsored by the United Nations and are available to any of the developing countries.

Future plans call for an expansion of programmes as well as increased co-operation with international standards groups. These international standards organizations have provisions for helping developing nations to establish standards systems. They include the International Organization for Standardization (ISO), the International Electro-technical Commission (IEC), the International Bureau of Weights and Measures, and the International Commission on Rules for the Approval of Electrical Equipment (CEE).

One of the most influential of these groups in the general fields of industry and engineering is the International Organization for Standardization, a non-governmental body which prepares standards for its members and publishes them in English, French and Russian. Its purpose, as stated in part in its constitution, is to "promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing mutual co-operation in the sphere of intellectual, scientific, technological, and economic activity". These are voluntary standards. However, because the recommendations represent a consolidated opinion of important trading nations, the standards are especially worthy of note by developing nations who wish to enhance their position in world commerce.

The ISO is comprised of national standards organizations from fifty-one countries who work together to produce standards acceptable to all members to facilitate international commerce. Standards groups representing some nations are voluntary and non-governmental in nature, such as the American Standards Association of the United States; others are governmental, such as the Korean Standards Association, Ministry of Commerce and Industry for Korea. It should be noted that the ISO has made it possible for developing countries who have not yet organized a national standards group to obtain correspondent membership. Upon payment of annual dues, correspondent members may attend any ISO technical meetings and may receive, free, ISO publications to a certain total face value. Additional publications may be purchased at a discount.

The ISO is now considering more than a hundred projects through the work of its active technical committees which are responsible for developing recommendations for international standards. Any ISO member may request that a technical committee be established to consider an international standard. The committee is made up of ISO members appointed on the basis of technical interest. Members who do not wish to participate actively in a project may be designated as observers so that they can be kept informed of the project's progress.

Once a draft has been drawn up by a committee, it is circulated to all member groups for comments. If 60 per cent of the members voting approve the draft, it is sent to the ISO governing council and, if the council approves, it becomes an official ISO recommended standard.

That so many nations with divergent industrial uses and customs must accept the standard means that the intent of ISO standards is to establish minimum requirements. Still, they are beneficial to developing countries for use in international trade or as a guide for preparing national standards. Some twenty-two nations, for example, have been able to work out an international code for boilers with jackets of carbon steel. The code establishes uniform material specifications, rules of construction, methods of inspection and certification. Developing nations which import equipment will benefit from this standard in particular because it provides a common basis for commercial competition.

Preliminary approval has also been given to an ISO recommendation on standards for freight containers. The standard would enable freight containers to be transferred between land and sea carriers without rehandling the contents.

Regional groups have also made significant contributions in standards implementation.

The Pan American Standards Committee (PASC), for example, has brought together representatives of Argentina, Brazil, Chile, Mexico, Peru, Uruguay, Venezuela, United States, Costa Rica, Guatemala, Honduras, Nicaragua, Panama and El Salvador. Their aim is to propose continent-wide standards to stimulate internal and external trade in Latin America. The committee works towards basic standards in fundamental symbols, units and magnitudes; ferrous metallurgy; building materials; electrical engineering; rail and road transportation; textiles, and food and cattle products. It is significant that the PASC has received vital assistance and co-operation from the International Standards Organization, the International Electrotechnical Commission, the American Standards Association and United States industry.

The standards used in the older, more developed countries can be examined through several other means besides active participation in an international organization. Through educational exchange programmes, for example, young engineers can study in countries which have advanced systems of standardization. Often, these young people are given the opportunity to apply what they have learned by working in the country in which they were educated. In this way, they can acquire a practical knowledge of the application of standards in a

particular field. Since many of these young people are sponsored by their governments, they can be directed to obtain proficiency in an area such as standards to ensure that information is brought home for use in preparing a national standards system.

The Indian Standards Institution provides training in the field of standards engineering that is open to developing nations; in France, the *Association pour l'organisation des stages en France* and the *Association Française de normalisation* provide group training in standardization.

Since one reason for instituting national standards is to become better equipped for world trade, a developing country can send a commission to study the standards system of a country with which it expects to have commercial relations. If it is feasible for the developing country to make its standards of production compatible with those of another country, the materials it produces will be immediately usable by that country and a basis for trade will be established.

Many of the highly developed countries will sponsor study groups from developing nations, providing information and assistance that can be used for establishing standards for international trade or internal use.

It is also possible for a developing nation to contract with a private consultant for various studies and for recommendations on how to proceed with a programme of national standards. At least one country has already used this means for producing a national bureau of standards.

The developing country, too, can benefit from having its plants established by manufacturers from older, more advanced nations. The manufacturer will bring with him a broad knowledge of standards and a knowledge of how to adapt them.

Although there are many resources at the disposal of developing countries for preparing national standards in metalworking, care should be exercised before standards of other countries are adopted in their entirety. Each country and often each area of a country has special conditions that may have precipitated one or more of the detailed requirements of a standard. If these conditions do not exist in the developing country, conformity to the standard may be difficult and may cause problems rather than solve them.

Voltage requirements for electricity, for example, vary from country to country. A 120 volt, alternating current, 60 cycle appliance can be used anywhere in the United States, but not in some fifty other countries. If a developing nation adopted a standard from a country with a different voltage system without taking the difference into consideration, the standard would be virtually useless. Likewise, a standard for a metal product containing bearings produced for a temperate region would be valueless for a tropical climate.

Each country should therefore carefully determine its standards. For international trade, it must obtain knowledge of the standards of other countries to establish a common basis for buying and selling. For internal consumption, it must develop standards that give its citizens what they need and want and at the same time provide the metalworking industry with standards it can accept practicably. It is important that standards be adopted that will encourage the development of a healthy and profitable manufacturing industry and that will not be a hindrance later.

Conclusions and Recommendations

If developing nations are to achieve the degree of industrialization in metalworking that is required to provide goods for both internal and external consumption, they must have a system of standards. Experience has shown that production methods become harder to change as the industry becomes more complex. A comprehensive study in the beginning phases of industrial development will net fewer costly mistakes. Perhaps an example of the delay caused by a lack of adequate standardization proves this best: the manufacture of the first rotary steam engine in the United States was hindered for almost ten years because its developers were unable to get pistons and cylinders that fitted each other.

The early adoption of standard sizes of metalworking materials will allow the design of many products, based generally on a limited number of sizes of rounds, squares, and other standard shapes; a limited number of thicknesses and widths of sheet, strip, and plate; and a limited number of finishes. Time and money will not be wasted on the constant resolving of common problems. An engineer in company A need not spend time developing a screw that will fit a part provided by company B if both companies adhere to a common standard. By establishing and using a system of national standards, it is possible to ensure that a bolt will match a nut, that an electrical plug will fit an outlet, and that a lamp bulb will screw into a socket regardless of what company manufactures the product or where and how in the country it is used. Engineering time can be more efficiently utilized to provide better products and better product uses, and duplication of effort will be minimized.

A nation's industry will benefit from the exchange of information resulting from discussions for establishing standards. A more adequate and more complete solution will be effected when many are involved in developing it. Problems that may be pending in the future for one company may already be present in another; an information exchange through standards meetings can often provide an expedient means for solving the problems. Sometimes, too, the exchange of information benefits not only the standards problem but also problems in other industrial areas, as standards are so basic and fundamental.

Standards in the metalworking industry are requisite to three basic phases of industrial production: to modern production methods, because they provide for interchangeability and economy; to trade within a country, because they enable consumers in all parts of the country to use a product; and to trade with other countries, because they provide a common basis on which to communicate.

The difficulties of running a manufacturing plant would be compounded immensely if drill shanks came in

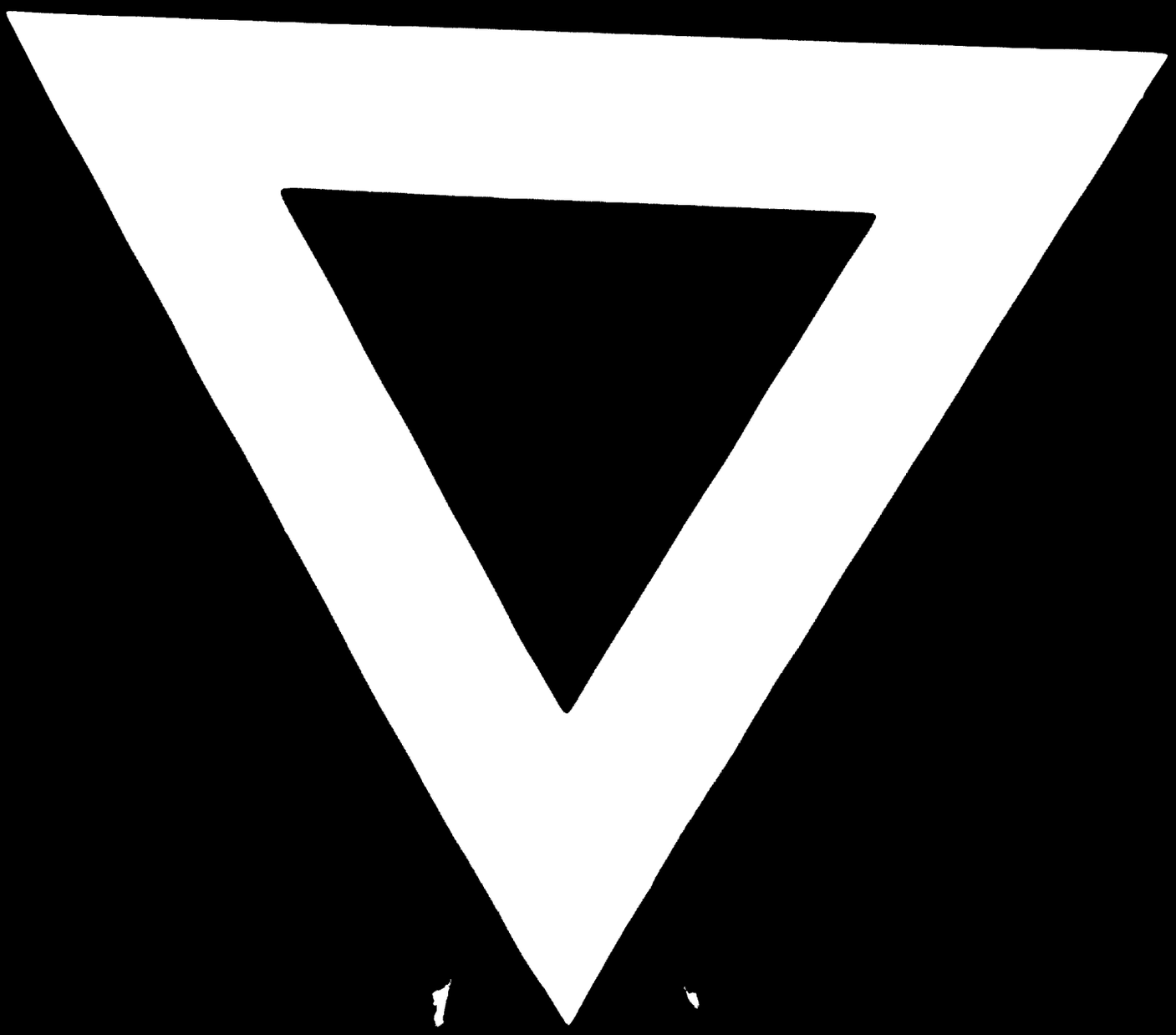
assorted sizes, if fuses were of non-standard sizes and electrical characteristics, if paint were not uniform in consistency and colour: in general, if standards were not used.

Standards, too, facilitate international commerce. For developing nations, the task of establishing an industry is eased considerably if the necessary goods and raw materials and procedures can be adapted from the experience of other nations. Problems can be alleviated and equipment more readily obtained.

A dramatic illustration of the value of standards in public safety and welfare is the tragedy of the fire that occurred in Baltimore, Maryland, in 1904. A large part of the city was destroyed because firefighting equipment from Philadelphia and New York was unusable. The hose couplings did not fit and the equipment could not be connected to the water lines. The experience of the past may not always provide such clear and dramatic reasons for the early implementation of standards, but a careful study of the past shows the many tangible and intangible benefits that result.

The ultimate goal of standards as expressed by the American Standards Association is "to make life in our machine age simpler, richer, and safer". This truism took decades to gain acceptance in the older, more developed countries. Today's greatest industrial nations have proved the necessity of standards in industrial success, or just for existence in the modern economic structure. All technical analyses have shown that the benefits of standardization spread throughout the economy. The nature of the metalworking industry makes standards especially important in its development.

The knowledge and study of previous mistakes as well as successes will prove beneficial to nations on the brink of modern industrial development today. The pace now will not allow for a long evolutionary process with its lessons of trial and error; the need is immediate and must not be ignored.



74.10.17