



BUSINESS PLAN
ISO/TC 213
Dimensional and geometrical product specifications and verification

EXECUTIVE SUMMARY

Geometrical product specifications (GPS) is an Internationally accepted concept (see ISO/TR 14638) covering all different requirements - indicated on a technical drawing - to the geometry of industrial workpieces (e.g. size, distance, radius, angle, form, orientation, location, run-out, surface roughness, surface waviness, surface defects, edges etc.) and all related verification principles, measuring instruments and their calibration. This can be expressed more simply as all requirements specifying the micro and macro geometry of a product (workpiece) with associated requirements for verification and calibration of related measuring instruments.

As such ISO/TC 213 activities takes place in a market where:

- Quality management systems according to ISO 9000 (including supporting standards) is of high priority;
- Sophisticated use of metrology is applied to verify functionally relevant workpiece requirements;
- Use of CAD/CAM-systems prevails;
- Use of out-sourcing and sub-contracting is increasing;
- GPS is the mean of communication in which designers, production engineers and metrologists exchange unambiguous information of what are the functional requirements of products;
- GPS documentation may be regarded as the basis of a binding legal contract.
- There is an increasing demand for highly sophisticated functions of workpieces at an economic price.

NOTE - This forces designers to detail the specifications in a degree where nothing is left open to interpretation. To fulfill this, it is necessary to improve the current system of GPS-standards where the standard definitions result in different interpretations or are insufficient for the purpose.

- US estimations for the world market of mechanical engineering cautiously provides figures for global annual expenditures of 14 trillion USD for all directly involved disciplines of the mechanical industry applying GPS standards - measuring equipment and measuring activities calls for 25,5 billion USD of this amount alone.

NOTE - These figures do not include estimates of used man-hours, generated costs of rejected workpieces or costs of legal disputes that will rocket these figures to a magnitude beyond human imagination.

In such a market, GPS is the only stable means of communication. Consequently, incorrect and ambiguous definitions of GPS-requirements constitute high economical risks to industry and are subject to disputes between companies. In this respect it shall be realized that empiric data shows that almost 80% of the costs of a product are engaged during the design phases and initial production phases of that product.

The main workload of ISO/TC 213 has its focus on improving the GPS-language. The improved GPS-system will provide a broader variety of tools necessary in order to express different functional requirements more precisely and with more complete and well-defined specification of workpieces. This improved GPS-system is a necessary **evolution – not a revolution** – of traditional dimensioning and tolerancing, which unquestionably has served worldwide industry well in bringing it to its high level of today, but has costly shortcomings that will not benefit the industry of tomorrow without extensive improvements.

The most important concept used as a basis for the improvement of GPS-standards in ISO/TC 213 is the concept of **uncertainty** according to GUM.

The uncertainty management is a tool to explain the discrepancies between measurement results from two different parties. However, it is generally realized that disagreements on the measurement values cannot always be explained by the presence of measurement uncertainty only. "Uncertainty" is actually only an expression for "lack of information". ISO/TC 213 has taken a closer look at discrepancies between measurement results from two different parties and recognized that the differences are due to different:

- Interpretation of the specification, and/or;
- Choice of influential conditions that are not pre-specified.

Therefore, ISO/TC 213 has defined another type of uncertainty, namely **specification uncertainty**.

It is the responsibility of ISO/TC 213 to develop unambiguous standards stating clear rules and to develop adequate tools for drawing indication and specification of all the necessary conditions that might affect any measurement result, e.g. filter type, stylus tip diameter, and mathematical calculation algorithms. An ambiguous drawing indication and/or incomplete specification will lead to specification uncertainty. Consequently, it is also the designer's/draughtsman's responsibility to use the GPS-system correctly according to the rules stated in the ISO standards.

ISO/TC 213 has introduced a third type of uncertainty called **correlation uncertainty** describing how well the actual GPS call out match to the actual function of the part. It is the intention of ISO/TC 213 to enrich the GPS-language to allow expression of requirements relating to a wide range of workpiece functions. It is the designer's responsibility to choose and use the special GPS relating most appropriately to the specific function of the part.

The fundamental ideas concerning the uncertainty management have great impact on the standards prepared by ISO/TC 213. If everything is specified, the specification uncertainty is eliminated, but this does not assure that the intended function of the part is described properly. If the function is not characterized by the specifications in accordance with the reality, the specifications may correlate badly to the intended function and therefore result in a correlation uncertainty.

To overcome this and for the purpose of obtaining more precise specifications in the improved GPS-system, ISO/TC 213 has developed the concept of "operators" (see ISO/TS 17450-2). The idea is to improve the GPS system with specification procedures parallel to the verification procedures, see ISO/TS 17450-1. When all the necessary specification operations are present and known, there will be no specification uncertainty. If the verification operators are identical to the specification operators, the measurement uncertainty will be relatively small depending, of course, on the practical circumstances.

The main goal of ISO/TC 213 is, therefore, to facilitate international commerce by developing a complete set of internationally accepted technically valid standards in the field of mechanical engineering as set forth in clause 7 of this Business Plan. In order to accomplish this, the most important objectives of ISO/TC 213 are:

Objective 1: To reduce the correlation uncertainty by developing the necessary functional related "tools" which makes it possible for the designer to express exactly what he needs.

Objective 2: To reduce the specification uncertainty by:
a) Identifying and defining operations that have influence on a characteristic
b) Developing clear and unambiguous rules
c) Stating default rules for the operations

Objective 3: To enrich the Geometrical Product Specification language and still strive to keep it as simple as possible

The reason being that proper implementation of the GPS system and its improvements:

- Reduces costs by avoiding the manufacture of inadequate workpieces due to incompletely defined specifications.
- Is a prerequisite for the continuous improvement of product quality and time to market.
- Enables optimum economical allocation of resources amongst specification, manufacturing and verification.
- Is important to industry in surviving in global competition.

A cautious estimate of French jet engine manufacturer SNECMA¹ is that the reduced manufacturing costs alone could match as much of 10 to 20 %.

¹ Source: French quality magazine *INDUSTRIES ET TECHNIQUES*, March 1999 Numero 802, ISSN 0150 6617, page 79

1 INTRODUCTION

1.1 ISO technical committees and business planning

The extension of formal business planning to ISO Technical Committees (ISO/TCs) is an important measure, which forms part of a major review of business. The aim is to align the ISO work programme with expressed business environment needs and trends and to allow ISO/TCs to prioritize among different projects, to identify the benefits expected from the availability of International Standards, and to ensure adequate resources for projects throughout their development.

1.2 International standardization and the role of ISO

The foremost aim of international standardization is to facilitate the exchange of goods and services through the elimination of technical barriers to trade.

Three bodies are responsible for the planning, development and adoption of International Standards: [ISO](#) (International Organization for Standardization) is responsible for all sectors excluding Electrotechnical, which is the responsibility of [IEC](#) (International Electrotechnical Committee), and most of the Telecommunications Technologies, which are largely the responsibility of [ITU](#) (International Telecommunication Union).

ISO is a legal association, the members of which are the National Standards Bodies (NSBs) of some 140 countries (organizations representing social and economic interests at the international level), supported by a Central Secretariat based in Geneva, Switzerland.

The principal deliverable of ISO is the [International Standard](#).

An International Standard embodies the essential principles of global openness and transparency, consensus and technical coherence. These are safeguarded through its development in an ISO Technical Committee (ISO/TC), representative of all interested parties, supported by a public comment phase (the ISO Technical Enquiry). ISO and its [Technical Committees](#) are also able to offer the ISO Technical Specification (ISO/TS), the ISO Public Available Specification (ISO/PAS) and the ISO Technical Report (ISO/TR) as solutions to market needs. These ISO products represent lower levels of consensus and have therefore not the same status as an International Standard.

ISO offers also the International Workshop Agreement (IWA) as a deliverable, which aims to bridge the gap between the activities of consortia and the formal process of standardization represented by ISO and its national members. An important distinction is that the IWA is developed by ISO workshops and fora, comprising only participants with direct interest, and so it is not accorded the status of an International Standard.

2 BUSINESS ENVIRONMENT OF THE ISO/TC

2.1 Description of the Business Environment

The following political, economic, technical, regulatory, legal and social dynamics describe the business environment of the industry sector, products, materials, disciplines or practices related to the scope of this ISO/TC, and they may significantly influence how the relevant standards development processes are conducted and the content of the resulting standards:

2.1.1 General

ISO/TC 213 activities takes place in a market where:

- The quality management systems according to the ISO 9000-series (including supporting standards) is of high priority to industry;
- Increasingly sophisticated use of metrology is applied to verify functionally relevant workpiece requirements;
- The use of CAD/CAM-systems prevails;
- The use of out-sourcing and sub-contracting is increasing;
- The GPS (geometrical product specifications) is the means of communication in which designers, production engineers and metrologists exchange unambiguous information of what are the functional requirements of products;
- The GPS documentation may be regarded as the basis of a binding contract.

There is an increasing demand for highly sophisticated functions of workpieces at an economic price. This forces designers to detail the specifications in a degree where nothing is left open. To fulfill this, it is necessary to improve the current system of GPS-standards where the standard definitions result in different interpretations or are insufficient for the purpose.

2.1.2 Political

ISO/TC 213 is striving at providing a complete set of International Standards based on an international consensus on GPS thus ensuring a well based set of uniform basic standards in support of all branches of industry and especially in support of the International, regional and national standards on product design and safety in relation to national and regional legislation and the uniform global realization of the ISO 9000-standards on quality assurance.

2.1.3 Legal

The situation where the GPS documentation is regarded as a binding contract is strongly emphasized in a worldwide business environment where out-sourcing of production tasks and the use of sub-contractors is common and steadily increasing. The organization of companies into geographically separated divisions is also increasingly common and often corrupts the traditional internal communication.

2.1.4 Economical

In such an environment, the GPS is the only stable means of communication. Therefore, the application of GPS is of vital importance for the insurance of the fulfillment of the specified function of the workpiece and the final assembly (product). Consequently, incorrect and ambiguous definitions of GPS-requirements constitute high economical risks to industry and are subject to disputes between companies. In this respect it shall be realized that empiric data shows that almost 80% of the costs of a product are engaged during the design phases and initial production phases of that product.

2.1.5 Technical

Computer based technology is increasing and the opportunity of human interaction is thus reduced. Consequently, there is a need to model relevant knowledge for integration into CAD/CAM/CAQ-systems. This applies to the GPS field and calls for unambiguous definitions of GPS requirements.

The potential users are industry in general, primarily the segments producing engineered mechanical parts. These users need to be provided with globally standardized tools for communicating GPS unambiguously.

The developers of CAD/CAM/CAQ-software and systems as well as manufacturers of measuring equipment are user segments providing GPS tools in support of the primary users.

ISO/TCs providing standards for the above user segments shall be advised of the status of the GPS-standardization and receive the assistance and close cooperation of ISO/TC 213. Special attention shall be given to those ISO/TCs, which are handling GPS-related matters within their Scopes and in the field of application of their standards.

Derived from the above, the total size of the market is unknown, but must be immeasurably immense.

2.1.6 International factors

The importance of international trade in the market sector has been addressed, together with an analysis of related ongoing regional standardization activities (especially within CEN/TC 290) and their economic impact. Consequently, the work programme and not least the priorities of ISO/TC 213 are coordinated with those of CEN/TC 290 and have been determined largely by the market environment.

2.2 Quantitative Indicators of the Business Environment

The following list of quantitative indicators describes the business environment in order to provide adequate information to support actions of the ISO/TC:

The market size for GPS standards is almost impossible to evaluate due to its vastness. The absolute fundamental nature of GPS makes it a born prerequisite for the specification of any imaginable product within the mechanical engineering disciplines. Every industrially employed person of the approximately 6,3 billion people on planet Earth occupied within departments of design, manufacturing, metrology and quality assurance is a user or potential user of GPS standards. The world population is growing and, therefore, the usage of GPS standards is growing².

Very few companies in this world make any production without some sort of sketch or technical drawing of the intended product and by far they all use tolerancing of the geometrical characteristics of that product and they all use some sort of measuring equipment in assessing the validity of the manufactured product. If this statement is taken as a fact, the market share of GPS standards³ amounts to 100% of which ISO made GPS standards probably amounts to 50%. World employment for mechanical engineers is expected to grow about as fast as the average for all occupations through 2010, with information technology, biotechnology and nanotechnology opening up a whole world of opportunities.

Consequently, the estimation of actual numbers of standards purchased, used, cited, quoted etc. is very difficult in a market where recent US estimations for the World Market of Industrial output is 14 trillion USD and mechanically engineered products and the involved disciplines of the mechanical industry that apply GPS standards are responsible for a large portion of this World Industrial Output. Measuring equipment and measuring activities alone amount to 25,5 billion USD and this does not include estimates of used man-hours, generated costs of rejected workpieces or costs of legal disputes, which will rocket these figures to a magnitude beyond human imagination.

Furthermore, some countries such as France have initiated large programmes to develop GPS infrastructures and others are proposing it such as UK, Japan and the P.R. of China. The proposed programme of P.R.China calls for a budget of \$ 4 200 000 for the setting up of a GPS virtual institute and an integrated knowledge database of product functions, standards and metrology.

3 BENEFITS EXPECTED FROM THE WORK OF THE ISO/TC

Proper implementation of the GPS system and its improvements:

- Will reduce costs by avoiding the manufacture of inadequate workpieces due to incompletely defined specifications.
- Is a prerequisite for the continuous improvement of product quality and time to market.
- Will enable optimum economical allocation of resources amongst specification, manufacturing and verification.
- Within a company is important for surviving in global competition.

A cautious estimate is that the reduced costs alone could match as much of 10 to 20 %.

² Source: US Census Bureau, International Data Base 7-2004, prediction in world population 1950-2050

³ Including versions prepared by ISO and national and/or company equivalents or conversions.

4 REPRESENTATION AND PARTICIPATION IN THE ISO/TC

4.1 Countries/ISO members bodies that are P and O members of the ISO committee

4.2 Analysis of the participation

Among the P-members there is no participation by any developing countries. The reasons for this lack of participation can only rely on a guess, which includes factors such as, lack of travel funding, lack of significant major international industries.

The P-members represent a well-balanced geographical spread that encompasses North America, South America, China, Japan, Australia and Europe. The only region with a significant experience in the field of GPS and whose strengthened participation would be appreciated is South America. For the time being only Mexico maintains an O-membership.

4.3 ISO-liaisons

The most important internal ISO liaisons are ISO/TC 10, ISO/TC 176 and ISO/TC 184/SC 4 with which an extensive cooperation takes place. However, the liaison to ISO/TC 176 has for the time being a nature characterized more by monologue than dialogue, and have to be addressed an intensified effort in achieving a higher level of mutual understanding and cross-reference. The latter is still not the case since ISO/TC 176 is ignoring significant inputs from ISO/TC 213.

4.4 CEN-liaisons

From the outset, the major strategic objective of ISO/TC 213 is to provide acceptable solutions for the global market. Consequently, ISO/TC 213 has a very efficient liaison with CEN/TC 290 including an deliberate synchronization of the work programmes obtained to a degree where all new work items are created in parallel by both TCs, using the Vienna agreement for the continued progress of work under ISO lead. This procedure is based on the CEN/TC 290 recognition of needs for an international understanding on GPS which is not limited to European points of view, which caused the decision of CEN/TC 290 to wherever possible not to develop European Standards which would be different from ISO, but to cooperate with ISO on the basis of the Vienna Agreement. Efficient mechanisms for co-operation have been established, involving e.g. regular co-ordination meetings. A joint CEN/ISO document is maintained providing cross-references and a total overview of the work programmes of the two committees. The success of this strategy is proven by the fact, that CEN/TC 290 has not found it necessary to initiate separate regional European work.

4.5 Other international liaisons

Besides important major ISO and CEN activities, ISO/TC 213 maintains liaisons with other international organizations such as OIML and AIAG (Automotive Industry Action Group). The latter has a massive impact on the stakeholders due to the technical directives e.g. QS 9000 and Measuring Systems Analysis (MSA) manual of its huge global parent companies.

4.6 Industrial participation

When subtracting the important major participation of national measurement laboratories and research and consulting businesses which when counted as one have a significant turnover, the absolute major industrial participants of ISO/TC 213 in both terms of magnitude and turnover are those representing manufacturers of cars, airplanes, computers and metrological equipment. These industrial key players have a predominant geographical distribution restricted to North America, Japan and Europe.

5 OBJECTIVES OF THE ISO/TC AND STRATEGIES FOR THEIR ACHIEVEMENT

5.1 *Defined objectives of the ISO/TC*

Based on the considerations above, ISO/TC 213 has stated the following objectives and strategic directions for its work:

ISO/TC 213 shall to provide an open forum for all ISO member bodies and external liaisons for the processing, implementation and maintenance of ISO Standards relevant to GPS. This will facilitate global trade and sustain long-term worldwide co-operation and to provide a standardized set of GPS-communication tools, which enables industry to exploit optimally, advanced technology and technical know-how. Focus is set on the next generation of the GPS language, in which the integrated GPS system for specification and verification of workpiece geometry shall become improved engineering tool for product development and manufacturing. This GPS system is necessary, as companies are rapidly moving ahead with new technologies, new manufacturing processes, new materials and visionary products in an environment of international outsourcing.

The objective of the improved GPS system is to provide tools for the economic management of variability in products and processes. This will be achieved by the use of a more precise method of expressing workpiece functional requirements, complete and well-defined specifications, and integrated verification approaches. This improved GPS system will clarify the current practices and be harmonized with the work of other relevant ISO/TCs. This harmonization will, for example, enable better integration with 3D CAD/CAM/CAQ-systems.

The improved GPS system will be based on the experiences from the use of current practices and traditions. The legal and technical contents of existing drawings will be left intact, realizing that there is a vast domain of existing specifications, which cannot be changed without the explicit or implicit consent of those responsible.

5.2 *Identified strategies to achieve the ISO/TCs defined objectives*

5.2.1 *History*

Formerly, most companies had their design and manufacturing facilities on the same site. This facilitated a high degree of mutual understanding between designer, workshop and metrologists. In such an environment, the shortcomings of technical drawings, manufacture, verification procedures, and the related standards were not critical to the success of the product. Today where such environments still exist, this is still true. However, now that outsourcing is becoming increasingly common, this understanding cannot be present, thus forcing the technical documentation to be much more precise.

Furthermore, technology has improved with increasing demands for the manufacture of more precise parts at less cost. For companies with design and manufacturing facilities on the same site, the old tools of dimensioning and tolerancing may still be valid, but not necessarily the optimum for all new designs. These increasing demands require more flexibility in the standards, which must provide for a broad variety of tools of dimensioning and tolerancing in the "standards-tool-box" including already established tools as well as the development of new tools. Consequently, the GPS standardization of the past, present and future represents **an evolution – not a revolution** – leading to a more mathematical and scientific basis of standardization building on the already established craft based foundation of past standards enabling a better interface to scientific knowledge of product functions.

Furthermore, it is recognized that there are two metrology systems in GPS:

- Conventional metrology based on hard gauging (surface plates, dial gauge indicators etc.), and;
- Digital computational metrology based on sampled points and computer software analysis (CMMs etc).

The addition of digital computation extends conventional metrology and makes it much more flexible, since by using computers, almost any perceived measurand can be calculated. The challenge is to mathematize

the conventional measurands so they are applicable in both systems. Further many mathematized conventional measurands can be split into more diagnostic measurands in digital computational metrology to give a very flexible toolbox of measurement techniques (e.g. runout can be split into location, form and waviness in a single measurement using digital computational metrology).

ISO/TC 213 was created to harmonize the standardization of design, manufacture and metrology, in order to meet the above new demands. There was a necessity to link the former individual standardization of geometrical tolerancing and related metrology, surface texture and related metrology, and dimensional tolerancing and related metrology together to form an integrated and complementary system, since these items were formerly dealt with separately by three individual Technical Committees within ISO. The creation of ISO/TC 213 on 16 June 1996 established the basis for a new ISO structure according to the GPS matrix captured in ISO/TR 14638.

Existing dimensioning and tolerancing practices leave a lot to be desired! I.e. the technical drawings are not necessarily unambiguous. Experience shows that the average costs involved amount to as much as 20% of the production turnover.

The reason is not that the designer does not know what he or she wants, or that the workshop does not know how to comply with the drawing. The reason is lack of effective communication via the technical drawing, resulting in misunderstanding from idea to the real thing. The poor communication arises from the fact that the parties do not necessarily know the "grammar" of the drawing and in particular from the fact that the available standards may not have adequately kept pace with development of the industrial needs and technology.

The technical drawing serves its purpose only if it is unambiguous and results in the production of one single type of identical products with one single type of functional characteristics. The designer is responsible for ensuring that the technical drawing is unambiguous. The standard writers are responsible for ensuring that the designer has available to him the proper tolerancing tools - namely the standards.

There is an apparent need for improving the technical communication between the designer and the workshop. Several elements of the communication can be improved:

- 1) The human understanding and knowledge of the symbol language used on the drawing and which expresses the requisite functional characteristics of the workpiece by means of geometry and related tolerances.
- 2) Drawings shall be made more precise and unique which means that they shall specify all requirements that are essential for the workpiece functions.
- 3) A complete, highly developed, systematic and standardized "language" is needed to express and translate the function of the workpiece into geometrical requirements on the drawing.

Re 1):

The first improvement can be obtained only in part through improved and more deliberate standardization and will therefore to an increasing extent have to be based on more stringent requirements from the industry to the technical educational system.

Re 2):

The second improvement would urgently require updating and modernizing of the existing standardized dimensioning and tolerancing system available. Technological development since the Second World War has practically not been taken into account.

Historical research shows that dimensional tolerances (e.g. diameters, distances, etc.) as a main rule are reduced by an average factor of 10 over 50 years and this "law of reduction" can be traced back more than 200 years. It will probably not change in the future - on the contrary, the present and future production and process methods can control these dimensional tolerances as well as the required measurements - during and after production - which are necessary for obtaining the smaller and smaller tolerances. Other

geometrical characteristics, such as form, orientation, location and run-out and the macro and micro geometrical form characteristics of surfaces, are quite another story.

These geometrical characteristics cannot be controlled during the process as they usually depend on parameters which cannot be controlled during the process and it is often the choice and order of the process(es) and the choice of material which have a decisive influence. Today the resulting geometrical deviations can be relatively larger than the dimensional deviations, the difference being greater than before - the deviations are in fact so considerable that they obstruct the function of the workpiece as well as dimensioning and tolerancing. Geometrical deviations must consequently be limited to a tighter degree than before by means of geometrical tolerances to ensure correct function of the workpiece and the relevance of dimensional dimensioning and tolerancing.

The situation is that a marked shift has taken place between dimensional deviations and geometrical deviations of form, orientation, location and run-out. However, the problem is that the way of drawing and tolerancing has not changed. The ISO dimensioning and tolerancing system is, in part, based on the old ISA system which dates back to the 1940s, the ISO roughness system is from the 1950s. Furthermore, the ISO dimensioning and tolerancing system works only on theoretically correct workpieces - and not if deviations of form and angles occur - the result is a drawing which does not specify sufficiently precisely what is required of the geometry to obtain the desired function. As a consequence, far too much is left to the (random) decisions of other departments within the organization than the design/engineering department.

It is therefore perfectly permissible to maintain the following:

- Often, it is not the designer who decides the end function of the workpiece;
- Often, it is the measuring and gauging people who unwittingly establish the functional characteristics of the workpiece by their (random) choice of measuring methods and equipment or the function is decided by the software integrated into the equipment;
- Where coincidence reigns, quality cannot be controlled;
- Subcontractors are at a loss.

Re 3):

The task of standardization is to provide design/workshop/quality management with the tools necessary for producing workpieces with the optimum function and the characteristics desired by the designer. The tools are the following:

- Unambiguous and precise rules for "translation" from function to "geometry".
- Elaborate rules allowing all specific "geometry" requirements to be expressed precisely and unambiguously.

Optimum implementation of such standards is conditional upon the following:

- The designer knows the problems and the standards and learns the "geometry language" to perfection.
- Personnel involved in production, inspection and measuring also know the problems and the standards and they know the "geometry language", offering them the possibility of producing the desired geometrical characteristics.

If the tools fail - the system falls apart. Failure is most often caused by:

- Limited knowledge and understanding of the correlation between workpiece function and workpiece geometry

- Limited knowledge of the possibilities of expressing geometrical requirements on the drawing and of essential details of the standardized drawing practices
- Limited knowledge of the "geometry language" on the part of workshop, inspection and measuring personnel
- An inadequately standardized tolerancing system for engineering drawings.

The fault on the part of the standards is that until recently, the characteristics indicated on drawings were only defined in theory, i.e. for perfect workpieces. As soon as the real life reveals itself with e.g. deviations of form etc., the theoretical definitions no longer apply. The requirements lose their meaning or become foggy and/or ambiguous. The immediate result of the failure of the standardized tolerance definitions in the "real world" is that in practice the choice of measuring procedure and/or equipment will influence the results obtained by the measurements. In addition, the value of the measurement result will in many cases be heavily influenced by the errors of form etc. of the workpiece - with an influence from other geometrical characteristics than the characteristic, which is actually measured.

As a consequence, tolerances on drawings are not necessarily unambiguous. As a result, the function of workpieces may not be under control unless overly restrictive tolerances are applied. If there is no ambiguity in the indications on the primary drawings, the production drawings, and the verification results, all tolerances could be considerably larger - and a lot of money could be saved.

5.2.2 Fundamental technical tenets for the accomplishment of the scope

ISO/TC 213 has decided that the planning of new standards, the revision of standards and the preparation of standards is based on the following tenets:

- **Controlling function:** controlling the geometry and the material properties of the workpiece(s) making up the product can ensure the intended function of a product. GPS is the language for controlling geometry only and its evolution will be based on computable mathematics and correct, consistent logic using a generic set of rules that can be applied to all types of specifications. The challenge for the future is to enrich the GPS language to allow expression of requirements relating to a wide range of workpiece functions.
- **Uncertainty – An economical tool:** The improved GPS system will use "uncertainty" as the "currency" for quantifying:
 - a) How well the specification expresses the functional requirements,
 - b) The ambiguities that exist within the specification itself,
 - c) The uncertainty of measurement.
- **Simplification:** The improved GPS language will be richer, more precise and, therefore, more verbose. However, in most cases, the complexity of drawing indications will not increase due to the consistency of the logic and the "default" concept. There will be a global default for each type of GPS specification, which is based on simplicity and minimization of total cost. In addition, there will be a number of shorthand indications covering commonly occurring workpiece functions, e.g. fits.

5.2.3 Basic philosophies for management of the scope

ISO/TC 213 has decided to base its planning of new standards, the revision of standards and the preparation of standards on the following two philosophies:

- "*Chains of standards*"-philosophy as presented in ISO/TR 14638, "*Geometrical product specifications (GPS) - Masterplan*",
- Expression and estimation of uncertainty according to "*Guide to the expression of uncertainty in measurement*",

according to ISO/TR 14638, the following rules shall apply to the preparation of ISO/TC 213 standards:

- **Rule of unambiguity:** Each chain of standards, assisted by Global GPS standards, shall include the necessary definitions and rules, that unambiguity exists between the drawing indication and the geometrical characteristics of the workpiece and that the assessed value(s) representing the characteristic is (are) traceable to International physical calibration Standards.

NOTE The rule of unambiguity is influencing the content of the standards in the various chains of standards and the Global GPS standards, and ensures also that each measurand in the chain is measurable.

- **Rule of totality:** The General GPS matrix - consisting of individual chains of standards and assisted by the Global GPS standards - shall contain the necessary different possibilities so it is possible to indicate all the required geometrical characteristics on the drawing.
- **Rule of complementarity:** Each of the individual chains of standards shall be complementary to the other.

NOTE The rule of totality is influencing the number of chains of standard. The rule of complementarity ensures that the individual requirements on the drawing are independent of each other, that no unintended interference occurs between multiple requirements.

In addition, the following apply:

- **Rule of terminology:** All standards of ISO/TC 213 shall respect the terminology of VIM "*International vocabulary of basic and fundamental terms in metrology*" and GUM "*Guide to the expression of uncertainty in measurement*". All new definitions shall be drafted according to ISO 10241, "*International terminology standards - Preparation and layout*".

5.2.4 Major specific tasks to be accomplished

According to ISO/TR 14638 and the experience gained in the past, there is a huge gap in the necessary GPS-standardization. An estimated 50 % of the necessary standards are either not available or are in contradiction to other GPS-standards. This calls for immediate action as to coordination and harmonization of the existing standards and their improvements (revisions) and the elaboration of standards on e.g.:

- Harmonization of the terminology;
- Default-definitions on datums e.g. "Convex-Hull"-approach;
- Default-definitions and measuring criteria for indications of dimensions, angle and radius;
- Default-definitions for roundness, cylindricity, flatness and straightness;
- Preparation of a unified GPS-symbolology incl. improved harmonized symbology for the indication of surface texture (revision of ISO 1302) and geometry (revision of ISO 1101);
- Reformation of requirements for measuring instruments (so that they "fit" to quality criteria according to ISO 9000);
- Revision of definitions of edges/corners;
- Preparation of definitions of deviations;
- Textual equivalents for geometrical symbols and symbols on surface texture in order to facilitate the alpha-numeric notation e.g. by the mean of computers;
- Mathematization of GPS-definitions in order to facilitate standardized inputs to:
 - Software designers for computing algorithms in metrology;
 - Software designers for CAD-systems;
 - Standards makers on STEP (computerized exchange of product data between CAD-systems).

5.2.5 Operations/organisation

ISO/TC 213 has ensured a flat organization of work in order to optimize the administration and to facilitate a short communication structure from decision to action and thus ensuring coordination and short production time. Furthermore, a flat organizational structure is anticipated to ensure time and cost savings for the delegates.

This flat organization consists of Working Groups and Advisory Groups.

ISO/TC 213 ensures that the Working Groups have a well-defined task with respect to the Masterplan in order to avoid contradictions, fill in gaps and to respect the agreed target dates.

The working language of ISO/TC 213 is English only.

Since September 1999, ISO/TC 213 is operating fully electronically and focuses all its activities on its web site: <http://isotc213.ds.dk/> and the ISO Livelink.

5.2.6 Meetings

ISO/TC 213 will convene at a regular basis and preferably twice a year. This is necessary to ensure efficient coordination and supervision of the work.

ISO/TC 213 will ensure that the Working Groups meet regularly to maintain the impetus of the work programme review. ISO/TC 213 will review the meeting schedule of the working groups on a regular basis and recommend possible improvements.

Some Working Groups need coordination with other Working Groups while others can operate independently. Those Working Groups in need of coordination with other Working Groups should preferably meet in conjunction with meetings of ISO/TC 213.

Meetings of ISO/TC 213 require the following provisions for:

Meeting place:

- Copying capability of large numbers of copies at short notice,
- Printing capability from laptop computers (laser printers etc.),
- Computer link projection by PC-viewer and AV-facilities including strong overhead projectors with metal-halogen light-bulbs, whiteboards, flip-charts etc.,
- Meeting places easy to reach (e.g. close to international airports).

Hotel accommodation:

- Hotel accommodations near or at the same place as the meeting place (meetings at hotels).

5.2.7 Resources

Due to the amount of very important tasks it is necessary that ISO/TC 213 make the best use of the scarce resources available. This requires an increasing use of IT-tools, for example, electronic mail, electronic exchange of documents as to facilitate a rapid progress of work. The aim is to minimize the paper flow and increase the use of PCs, documents in electronic format (e.g. USB-memory sticks, CD-ROM, Internet, homepage, Livelink etc.).

For this purpose ISO/TC 213 operates fully electronically as per September 1999 and focuses all its activities on its web site: <http://isotc213.ds.dk/> and the ISO Livelink.

5.2.8 Convener/Project Leaders

Every identified project leader/convener shall have sufficient support from his national member body or company/organization in order to provide the CD-drafts in a correct form and to assist (resolution of comments and corrections/modifications of drafts) the secretariat of ISO/TC 213 up to the stage of FDIS.

A detailed list of duties has been prepared taking into account the ISO/IEC Directives and the ISO/TC 213 ways of working and is captured in the "ISO/TC 213 Internal rules" also known as the "Conveners Starter Kit".

5.2.9 Permanent strategic committee

A permanent strategic Advisory Group, ISO/TC 213/AG 1 "*Strategic planning*", shall review the tasks and schedules and provide updated analyses of completeness of the work programme at regular intervals on the basis of the current and future needs of the user community and on the basis of ISO 14638:1995 "*Geometrical product specifications (GPS) - Masterplan*" which provides information of the amount of work that has to be accomplished. The Advisory Group shall propose priorities for preparation/finalization of standards. Its members are appointed solely by the ISO/TC 213 Plenary meeting independently of nationality.

ISO/TC 213 will ensure that only the most essential work items to the user community are included in the work programme. ISO/TC 213 will establish strict criteria based on the "chains of standards"- philosophy for approving new work items.

The main priorities to which ISO/TC 213 must pay special attention are:

- The elimination of gaps and contradictions among the Fundamental, Global and General GPS-standards
- The development of definitions and requirements for the specified geometry (incl. the basic layout for drawing indications to be dimensioned and proportioned by ISO/TC 10) which makes it possible to express the functions of workpieces and workpiece features in a degree far more detailed and unambiguous than today.

5.2.10 Permanent editing committee

As a quality assurance function of ISO/TC 213, a permanent editing committee, ISO/TC 213/AG 2 "*Final auditing standards team (FAST)*" is maintained with the task of reviewing all draft standards before submission to CD-, DTS-, DIS-and FDIS-ballots. The review shall ensure consistency of the:

- Terminology e.g. VIM, GUM, other standards of ISO/TC 213 and definitions drafted in accordance with ISO 10241 "*International terminology standards - Preparation and layout*",
- Technology e.g. GUM and standards of ISO/TC 213,
- Introductions, and,
- Informative annex "*Relation to the GPS matrix model*" of all standards of ISO/TC 213,
- Compliance with ISO/IEC Technical Directives Part 3 "*Rules for drafting and presentation of international standards*".

The review shall also confirm that drafts fit into the GPS matrix model according to ISO/TR 14638.

6 FACTORS AFFECTING COMPLETION AND IMPLEMENTATION OF THE ISO/TC WORK PROGRAMME

It is assessed that the known and possible major risks for the timely completion of the work programme consist of (in un-prioritized order):

- ISO/CS demands to deliver the projects (with the aid of a template that does not function properly in all language environments), and being more or less print ready, induces a lot more work and increased cost for the ISO/TC 213 secretariat and the secretariats of the working groups;
- Requirement for having French translations;
- The average of 11 months total delay within ISO/CS between the stages of DIS, FDIS and publication
- ISO/CS re-draughting of OK illustrations;
- Vast need for internal tutorials-as-you-go;
- Inexperienced convener ships and secretariats in ISO procedures;
- Lack of negotiation able pre-defined national mandates of delegates and experts;
- Lack of funding;
- Lack of global understanding that GPS and TPD is of an dynamic nature – not static;
- Large national TC-delegations;
- Large contingents of national WG-experts;
- High frequency of change of national experts causing decreased national continuity;

- Some geographically conditioned reluctance to participate whole-heartedly.

But the biggest factor is the extreme fundamental nature of the issues being standardized due to the lack of consistent international standardization in past that has led to a wide variety and sometimes very different national approaches that makes the harmonization efforts very emotional at times. Consequently, tight timeframes imposed by ISO/CS only adds negatively to the complex factors affecting the progress of the important work being performed and the diplomacy and tutorials needed in doing so.

7 STRUCTURE, CURRENT PROJECTS AND PUBLICATIONS OF THE ISO/TC

This section gives an overview of the ISO/TCs structure, scopes of the ISO/TCs and any existing subcommittees and information on existing and planned standardization projects, publication of the ISO/TC and its subcommittees.

7.1 [Structure of the ISO committee](#)

7.2 [Current projects of the ISO technical committee and its subcommittees](#)

7.3 [Publications of the ISO technical committee and its subcommittees](#)

Reference information

[Glossary of terms and abbreviations used in ISO/TC Business Plans](#)

[General information on the principles of ISO's technical work](#)