Sandvik Coromant Technical White Paper
GTC Guidelines
Introduction to Generic Tool Classification

GTC Guidelines – White paper

Communicating tool data among tool vendors and systems has always been quite a challenge. The introduction of the ISO 13399 standard has helped the communication process. In order to simplify the tool-data communication even more, Sandvik Coromant and Siemens PLM have developed a Generic Tool Classification (GTC) as a complement to ISO 13399.

GTC is a vendor-neutral catalogue structure for classification of cutting-tool components. Tool vendors can use GTC to rationalize their data-exchange process and ensure an excellent communication quality. In this way, both time and money can be saved.

1. Challenge

Sending and receiving tool data has always demanded a lot of manual work. It often includes reading from paper catalogues and manually putting tool data into tool libraries. Companies often use their own local standards for data description and management. Different organizations use different systems, which complicates the process. The basic difficulty is the absence of standardized structures and definitions. Manual data management is both cost- and time ineffective. Not only does it require a lot of manual work, it also limits communication between vendors and users. Furthermore, manual data handling always comes with the risk of human error.

ISO 13399, a new generic standard for description of cutting tools, is a first step in addressing these issues. Its dictionary with classes and properties for describing cutting tools eliminates previous difficulties regarding product description. However, ISO 13399 has no hierarchical classification structure that demonstrates what kind of cutting-tool component a particular product is. To be able to find and use the right tools in a cost efficient way, there is a need to combine ISO 13399 with a standardized catalogue structure for cutting tools. The structure should be generic and brand neutral.

2. Overcoming the challenge

By combining ISO 13399 with a neutral classification, cutting tool vendors, system vendors, end users and other stakeholders will benefit greatly. The main advantage is that tool data can be communicated easily. This way both time and financial resources can be saved. Therefore, Sandvik Coromant and Siemens PLM have adopted the ISO 13399 standard fully and developed a first version of a Generic Tool Classification (GTC) structure. By taking this initiative, both companies demonstrate how GTC can be used.

GTC is a basic and easy to adopt classification with close connection to ISO 13399. It is to be maintained by a governance organization that understands the need of digital cutting-tool data description. The development of GTC has been discussed with other tool vendors, CAM-system experts and end user that understand the need of such a system and support the initiative.

2.1 Purpose of GTC

The main purpose of GTC is to offer a generic structure for classification of cutting-tool components.

GTC should be used as a complement to ISO 13399. It is intended to:

1. Help pre-map classes and properties to the receiving systems' internal classification and properties;
2. Be a hierarchical classification structure that simplify searching for products;
3. Serve as a base structure for manual entry of own-defined or non-classified tools into catalogues, and thereby assist when filling in essential properties.

2.2 Business value of GTC

The more ISO 13399 is used in combination with GTC in the cutting-tool industry, the less time it will take to exchange cutting-tool data among various stakeholders.

Another important benefit of GTC is that its users can obtain product data directly from cutting-tool vendors. This way, new products are visible without any packaging by the CAM system vendor. The system vendors only do the pre-mapping from the official GTC to their internal structure. The product data is available for download via system services or movable media storages.

GTC is primarily intended to be used in environments where cutting-tool data is frequently needed, such as CAM environments. However, it can also be used in other business situations. GTC supports different steps in the manufacturing process, e.g. CAM systems, tool path simulation, shop floor management, inventory control, pre-setting, e-commerce and purchasing.

By adopting ISO 13399 and GTC, all involved parties are able to highly rationalize their working processes, saving both time and money.

2.3 GTC and ISO 13399 in relation to other classifications

Other classifications exist in domestic business situations and when cutting tools are only a small part of another classification, e.g. purchasing systems or e-commerce.

A major effort has been made in Germany by introducing the national DIN 4000 standard. It has a hierarchical structure but no clear definitions of properties. The DIN 4000 has a strict way of describing what properties are connected to each tool type. Although this is convenient, the rigid structure is inflexible when introducing new tool kinds.

ISO 13399, which GTC is built upon, on the other hand has an information model enabling flexible description of new tool types. Companies that adopt GTC can use it as a basic classification. Matching classes between GTC and other classifications can be used if needed. It is also possible to get GTC into the ISO 13399 suite of standards.

The DIN 4000 standard is increasingly trying to converge towards ISO 13399 with direct references to ISO 13399 symbols when possible. A closer connection between the two classifications is positive since it can provide the opportunity to use the strength of both classifications. Hopefully, a combination of strong qualities of both classifications can lead to one internationally recognized standard that meet the needs of all parties.

2.4 Philosophy of GTC

GTC is a classification hierarchy for cutting-tool components. Thereby it is to be seen as chapters and subchapters of a generic and unbranded catalogue. GTC applies commonly used denominations in the cutting-tool industry to define tool kind, making it logical and easy to understand. It is easy to know where tools belong in the hierarchy, and how to expand the structure when it does not cover a new kind of tool. GTC does not describe operation areas of each tool. No cutting data is provided. Instead it explains what each product is in commonly used denominations.

GTC is a complement to ISO 13399. The structure and hierarchy branches of GTC have a rule-based connection to ISO 13399 classes and properties. This means that when a cutting-tool component is described according to ISO 13399, it is possible to match it to the hierarchy leaf nodes of GTC where it fits best. If the GTC hierarchy does not comply with ISO 13399 classes and properties, there is a reason to extend the ISO 13399 standard. Such questions will be handled by the ISO 13399 maintenance agency.

GTC offers a natural way to navigate and search for cutting-tool components. It is possible to use limiting properties in the search.

2.5 Governance of GTC

In order to maintain its structure, GTC will as soon as possible be governed by a group of all stakeholders that adopt GTC led by a neutral organization.

3. Description of GTC

3.1 GTC content

The first version of GTC is only available in English.

GTC consists of four major parts:
1. The GTC hierarchical structure which contains:
   a. A cutting-tool component hierarchy;
   b. List of relevant properties for each leaf node in the hierarchy;
   c. Class drawings showing the most important properties of the products at the leaf nodes;
   d. Class icons for each node in the hierarchy.
2. The vendor catalogue, which consists of an assortment file. The assortment file contains products, classified according to the GTC structure with a reference to the GTC class they belong to. The assortment file also holds information that indicates to the receiver if data has been changed or a lifecycle change has happened or will happen.
3. Product data according to ISO 13399, preferably in ISO 10303-p21-format. The data can include links to optional referenced files. One p21-file for each product.
4. Referenced files such as STEP 3D models, 2D drawings, dimensional drawings or other documents that help to identify or describe products. These files are optional and could be separately accessed and downloaded from each vendor or via other media.

The GTC structure needs to be published in new releases if it is changed or extended. This is to be managed be the governance organization. Each cutting-tool vendor must provide the other three parts.

3.1.1 Product data

The product data for each product is supplied by the cutting-tool vendors. Product data includes the following:
- A product file (p21-file) containing data that describe the product, including properties with values. The product file also contains connection definitions that show how to assemble the tool. A product file should be available for every product.
- Reference to product drawings and models.
- A reference to the PLIB-file version. This is needed to be able to decode the product data in an accurate way.

The p21-file can contain links to connected documents, such as 3D STEP models for anti-collision testing or DXF files for 2D assembling.
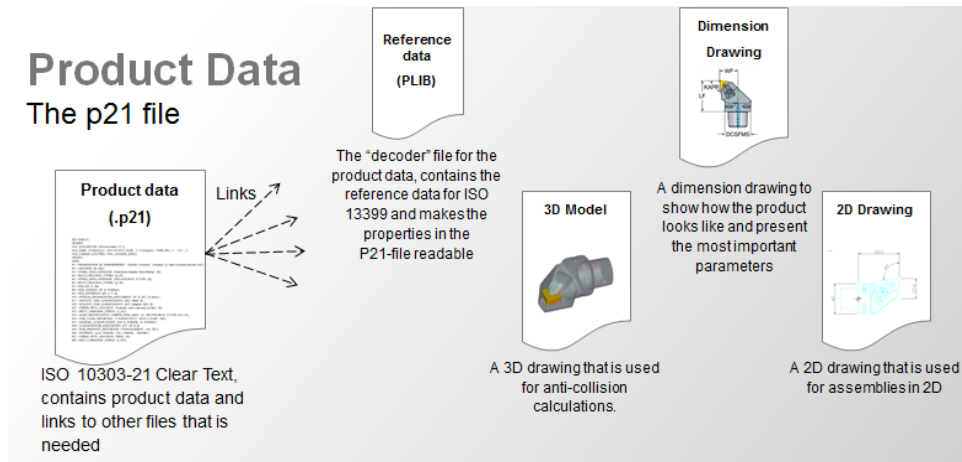
3.1.2 ISO13399 Reference data library (PLIB)

Properties that are used in GTC are defined in ISO 13399. They can be referenced and decoded through the PLIB-file.
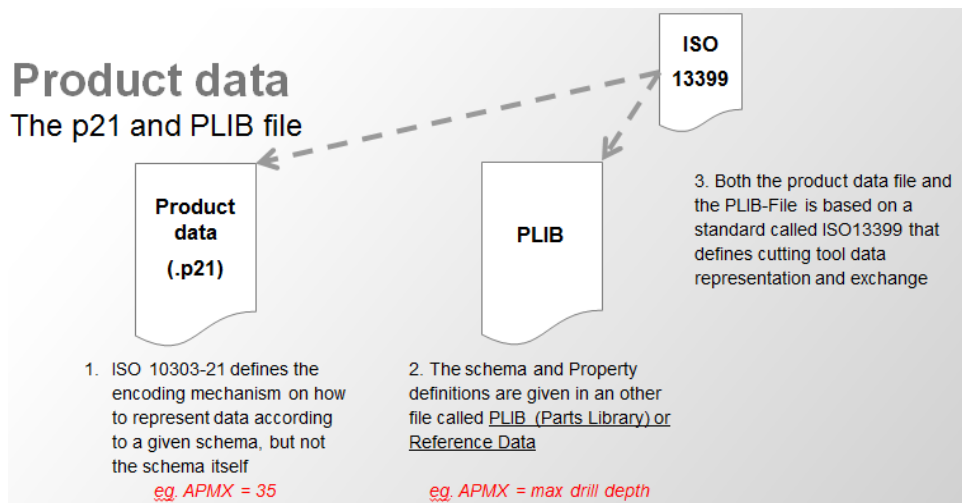
3.2 GTC hierarchy description

The hierarchy is based on typical denomination used in the cutting-tool industry for describing tools. The denominations are of the type that is used when seeing or holding tools – "tool in hand". Hence, the hierarchy is not based on the cutting operation products perform.

If a tool has multiple functions, e.g. a milling cutter able to drill holes, it can be classified in two different nodes of the hierarchy. Different nodes can thus include different sets of properties and values for the same tool. The product data file (p21-file) holds all the information about the tool.

The hierarchy consists of:

- Fixed levels that describe what kind of cutting-tool component an item is. It is a vendor neutral level. At this level, no specific property values or dimensions are used. Information about what connection types the tool type has is not present.
- Rule based levels that can be seen as variants of the same tool type. The same type of tool is split up in different kinds of connections or insert shapes. These levels are affected by which assortment each vendor has. They manage the different properties depending on connection type. They also help the guided search by splitting up the hierarchy in smaller identifiable sections.

Example of branches in the GTC structure.

In a system application, the lowest levels can be left out. The navigation is then based on property search instead of usage of property. All nodes in the tree structure have a rule-based relation to classes and properties in ISO 13399. Each node in the tree has an id, a denomination and two date stamps for version handling (see separate part for versions). The nodes can hold icons that represent the content contained below it.

3.2.1 The levels

The highest level (root) is "Cutting Tool product".

The second level shows the basic type of tool component, i.e. "Tool item", "Adaptive item", "Insert" (cutting item), "Assembly item" or "Accessory item". This categorization is the same as the basic types of cutting-tool components defined in ISO 13399. A cutting tool may consist of "Tool item", "Adaptive item", "Assembly item" and "Inserts". Equipment and hand tools used when assembling or setting the cutting-tool products in the workshop or tool room are called an "Accessory item". For the moment, the GTC does not cover "Accessory item" and "Assembly item".

The third level divides the different tool components depending on type of cutting-tool product. As mentioned previously, only "Insert", "Tool item" and "Adaptive item" are further divided in the GTC structure.

The cutting-tool vendors explicitly define which leaf node that tools belong to within an assortment file. In the lowest levels of the catalogue hierarchy, the leaf levels, there is a list of important properties that describe the specific tool. These leaf nodes can also hold an appropriate class drawing to help the user understand the meaning of the properties. Only the most essential properties appear in the leaf nodes. It could, for instance, be properties needed for building and using a cutting-tool assembly or for searching for the cutting-tool components that are used in the assembly. It is essential to define the properties that are needed. An important step is to enable end users to help limit the amount of properties to only those that are necessary.

4. Making it work

4.1 GTC usable formats

As a first intermediate solution, the GTC is defined in Excel format. It will as soon as possible be changed to a standardized ISO format and/or an XML structure with a specified schema. The aim is to put it in another ISO 10303-AP242 format, available from autumn 2013.

4.2 ISO 13399

To benefit fully from GTC, companies need to adopt ISO 13399, an internationally recognized standard for cutting-tool data exchange. ISO 13399 accommodates new tools with multiple functions without the need to change the standard. The biggest benefit of ISO 13399 is that it defines each property by itself. In other words, properties have the same meaning regardless of which type of cutting tool that is described. Therefore, ISO 13399 is a very consistent way of communicating properties. It standardizes the information that describes tools instead of the actual cutting-tool components.

ISO 13399 consists of an information model and a reference data library.
- The information model uses the STEP-standard ISO 10303-AP214 entities and schemas that are necessary in order to handle the cutting-tool data in a consistent way.
- The reference data library contains the classes and properties that are domain specific for describing cutting-tool parts in the cutting-tool industry. The library is managed and released by the ISO 13399 maintenance agency in a machine-readable file format, according to the PLIB standard ISO 13584 (Parts Library). The definitions of the properties are held in the PLIB-file (extension .spf). It also shows in which ISO 13399 classes the properties are used. The definitions also contain the id, the preferred symbols, the short names of the

classes and properties, as well as valid value sets for some properties.

4.3 Properties and conventions

The properties are defined according to the rules and reference systems of ISO 13399. However, some properties can appear multiple times for the same tool. Conventions for how to respond to this issue are needed. They can be specified and incorporated in ISO 13399 by the maintenance agency. Until then, such conventions are used as a kind of best practice solution.

4.4 Version handling for GTC

4.4.1 PLIB versioning

New versions of the PLIB-file are to be released by the ISO 13399 maintenance agency. The file name of the PLIB-file contains a version number, which is raised for every new revision.

The PLIB-file is available on the ISO 13399 maintenance agency homepage (http://www.unm.fr) under "Activities" → "Maintenance agencies" → "ISO 13399 Cutting Tool Reference Dictionary".

4.4.2 GTC versioning

A simple mechanism for version management of the GTC has been defined. It consists of two things:

1. A version number of the GTC version and release, such as GTC V1R7. In this example, V1 stands for version number one and R7 stands for release number seven. Versions are to be updated when major changes have been implemented. Releases are to be updated when minor corrections have been made.

2. A time stamp on each node in the hierarchy, making it possible to check which nodes in the hierarchy that have been changed in new versions and/or releases. Examples of changes are new-, moved- and removed nodes and changes in the property list in a leaf node. A new version date for a node is not made when changing an icon or class drawing, which does not have any effect on the structure itself.

4.4.3 Product data versioning

Each p21-file has two versions of time stamps:
1. One version tells when the structure is changed in the p21-file, which can require mapping changes in receiving systems. One example of such a change is when a property is added, deleted or changed.
2. The other timestamp is for value changes, e.g. corrections of data. This normally does not require any changes in receiving systems, but serves as an indication that the product is in use. As an extra service for the receiver of the product data, these timestamps are extracted and put into the assortment file to help the receiver judge if the

mapping or structure need to be changed. This way the receiver does not have to open each product data file to identify changes.

4.4.4 Product lifecycle changes

To be able to communicate product lifecycle changes from a vendor to a receiving user, there are three optional fields specified in the product assortment content file: product lifecycle, product life cycle change date and product lifecycle replacement. They indicate lifecycle state, when lifecycle change takes place and information regarding a suggested replacement product.

5. Conclusion

From manually sending and receiving cutting-tool data, ISO 13399 has offered new opportunities for fast and cost-efficient data exchange. Cutting-tool vendors can now use an international standard for description of cutting tools. Doing so eliminates the need of manual data handling and enables higher communication quality between vendors and end users.

GTC is introduced in order to complement ISO 13399. It is a generic tool classification. The hierarchical catalog structure defines cutting-tool components.

Combined with ISO 13399, GTC contributes with the following:
- High quality data exchange;
- Cost- and time efficient communication;
- Easily extendable structure;
- Global technical data download;
- No risk of human error.

The more ISO 13399 is used in combination with GTC, the less time it takes to exchange cutting-tool data between various stakeholders. Communication is made easy when users can obtain product data directly from cutting-tool vendors through the GTC system. In this way, new products are visible without any packaging by the system vendor. All product data is available globally for quick download via system services or movable media storages.

GTC is developed and functioning. Yet the biggest challenge remains: to involve all players in the cutting-tool industry.

Definitions and abbreviations

CAM (Computer-Aided Manufacturing) – The use of numerical control computer software applications to create detailed instructions that drive machine tools in manufacturing.

GTC (Generic Tool Classification) – A hierarchal classification developed as a complement to ISO 13399 to describe various cutting-tool component types.

GTC governance organization – A group of stakeholders led by a neutral organization responsible for management of GTC.

GTC leaf node – Nodes at the lowest levels in the GTC hierarchy. They hold properties used to describe the cutting-tool components.

GTC node – Nodes used to define a distinct tool type in the GTC system. GTC nodes can also be called GTC classes.

Hierarchy branch – Branches in GTC that describes various types of cutting-tool components.

ISO 13399 class – Information objects used to describe cutting-tool components with e.g. item types and features. The classes can hold one or more properties. They are defined in the ISO 13399 standard.

ISO 13399 maintenance agency – An institution for ensuring effective use of international ISO-standards. It handles changes and developments of the standard and publishes new PLIB-files.

Property – Object that is clearly defined by a definition. A property has an id, a preferred name and a symbol that represents it. Properties can, when used, be given a value that is geometrical or non-geometrical.

PLIB (reference data) – The decoder file for the product data. It contains the reference data to ISO 13399 and makes the properties in the .p21-file readable.

.p21-file (ISO 10303-21) – Text file that defines the encoding mechanism for how to represent data according to a given schema, but not the schema itself. Contains product data and links to other files that are needed.