Educational Software Application for Limit Gage Design

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Abstract: - A quick, simple, cost effective method of checking part was needed as a result of the industrial revolution and batch type production. Assembly line concepts required ease of use, little to no training and limit gages were the answer to this need. A limit gage is a device that determines whether or not one or more dimensions of a manufactured part are within specified limits. The use of an executable program, like the educational software application presented in this paper, provides an indisputable method of determining quickly the limit gage dimensions depending on the part dimension being gauged.

Key-Words:- limit gage design, educational software, Visual Basic

1 What is a limit gage ?

In order to check that a part is within the tolerances specified on the drawing, ISO has established special regulations for methods of inspection and measuring equipments. Verification of dimensional requirements can be accommodated through the use of coordinate measurement machines (CMM), fixed limit gages (gauges) and open inspection setups.

A quick, simple, cost effective method of checking part was needed as a result of the industrial revolution and batch type production. Assembly line concepts required ease of use, little to no training and fixed limit gages were the answer to this need.

The word gage**,** when used by itself, is about as general and unspecific in its meaning as the companion word tool. In discussing gages, we must first narrow the field down to a manageable size. First, then, we are talking about production gages, which came into being as a necessary step in the development of assembly-line production. Machine operators, working on parts with critical dimensions, were provided with gages, so that they could keep a check on wearing tools and other machine problems which prevent absolute uniformity in their work. The parts were then carefully spot-checked with gages in the subcontractor's inspection department before being shipped, and again at the assembly plant when received. This defines the area occupied by production gages. They are not often used in a home workshop, but in a complex industrial organization, they are all-important.

In order to limit this discussion to a manageable level, we are going to talk exclusively about fixed limit gages, which are basic and foolproof in their use. Limit gages or Fixed Limit gages or most commonly known as Go/NoGo gages are Attribute gages. Attribute gages check the extreme limits of the part tolerance letting you know the part is within its manufacturing limits. This will eliminate the extremely sensitive measuring equipment, which must be used under controlled laboratory conditions. It will also eliminate many devices, which have been designed to check concentricity, squareness, parallelism, exact position and other relationships between features, which are required in assembly. Other advantages and benefits of using fixed limit gauging are:

- The cost per part gauged is the lowest of all inspection methods making fixed limit gauging the most cost effective of all methods;
- Fixed limit gauging is both fast and portable;
- The size range, both small and large, is constrained by manufacturing "part size" limitations only;
- It is certifiable; offering traceability to industry accepted standards;
- Fixed limit gauging, when properly manufactured and calibrated, offers a unique "assurance of fit" with mating parts unavailable using virtually any other gauging method;
- Is the most conducive to using in a factory floor environment.

The concept of Go/NoGo gauging is so simple in its logic that it has been known to delight philosophers. For them, a Go/NoGo situation is the very rare case where there are only two alternatives - black and white - with no gray in between. In practice it is not quite so simple as this, since there are a few borderline cases which require a little human judgment. But the ground rules for using limit gages are certainly not complicated. Limit gages are used for Go/NoGo assessment so they accept all work-pieces dimensionally conforming to specification and reject all

work-pieces which do not conform. The Go gage fully receive the work-piece to be inspected and the NoGo gage does not receive the work-piece in any position.

So a limit gage is a device that determines whether or not one or more dimensions of a manufactured part are within specified limits. Gages are checking tools which embody the size and/or the form of the feature which is to be checked; gages can also be designed to check the position of two work-piece features with reference to each other. Gages are primarily used to check dimension and form; plug gages check internal and ring gages external dimension and form. Plug gages are available in two types: plain cylindrical and thread, and in several popular styles: reversible, progressive, taperlock and trilock - determined by the size of the gage. Ring gages are also available as plain cylindrical or snap gages and thread type gages.

2 Design principles of limit gages

Regarding the function of a part, the designer sets its dimensions and other characteristics in a complex process by using his creativity, experience and knowledge. Since the dimensions or other characteristics of a part cannot be exactly realized in manufacture, the designer must give some kind of limit values on the drawing. These stipulate the values according to which the parts are to be approved or rejected. So, to ensure quality of technical goods and their production and assembly processes, the dimensions and the other characteristics have to be limited and therefore toleranced. Tolerances are a communication of design, manufacturing, and inspection intent.

Strict application of the Taylor principle to check cylindrical parts entails the following gauging procedure:

a) The maximum material limit of the part is checked with a plug gage or ring gage of perfect form with a length equal to the length of the part, or the length of engagement of the part to its mating part, and a diameter exactly equal to the maximum material limit of the part. This gage should be able to fully pass into or over the part.

b) The least material limit of the part is checked with a gage designed to contact the part at two diametrically opposite points separated by a distance exactly equal to the least material limit of the part. This gage should not be able to pass into or over the part at any position.

Plug gages (fig.1) are used for checking an inside diameter, respectively a hole (bore). They have a machined diameter on one or both ends corresponding to Go/NoGo side dimensions that have been specified for the bore being inspected. The Go side of the plug gage is made to the minimum limit of size of the hole being checked and NoGo side to the maximum limit.

Ring gages (fig.2) are used to check outside diameters of parts (shafts) using the same Go/NoGo principle. Typically, they are made in pairs, with a NoGo ring being used for the minimum dimension and a Go ring being used for the maximum size limit.

Snap gages (fig.3) are similar to ring gages in purpose but operate in a different fashion. They are also used to measure outside diameters of parts but have an open-ended construction so that they can snap onto the diameter of the parts. The Go side is made to the maximum dimension of the shaft to be checked and the NoGo side to its minimum dimension.

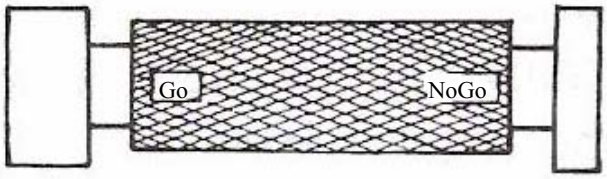

Fig.1

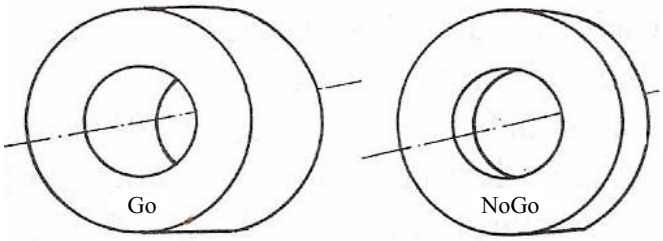

Fig.2

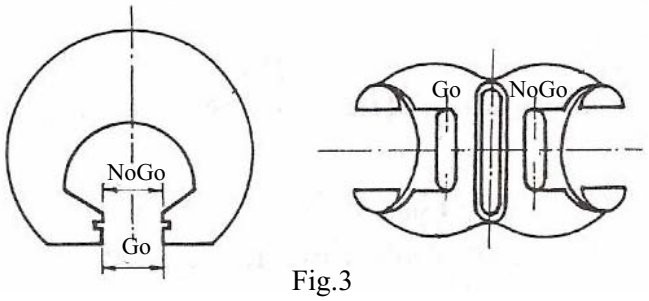

Fig.3

Because the fundamental concept of limit gauging is to never accept a bad part, in order to accomplish this, the tolerance of the plug or ring will be designed to actually have the potential to reject bad parts.

Therefore, a Go plug has a plus tolerance and is designed to gauge the smallest acceptable hole size, and a NoGo plug has a negative tolerance, designed to gauge the largest acceptable hole size. The opposite is true for ring gages. A Go ring has a negative tolerance and is designed to gauge the largest acceptable diameter and a NoGo ring has a positive tolerance and is designed to gauge the smallest acceptable diameter. It is easy to get confused between how the tolerance of the ring and plug is applied in relationship to the Go

and NoGo member. Sometimes it is easier to thing of the member you are measuring in terms of more or less material. The reason is that a plus tolerance applied to a plug, makes the actual plug size larger. The plus tolerance applied to a ring, makes the ring gauge diameter small.

The generally-observed rule-of-thumb, which has some statistical reasoning behind it, is that the gages can have a total tolerance no greater than ten percent of the part tolerance. So, the normal practice for determining gage tolerance is to allow 10% of product tolerance to be divided between the Go and NoGo gages. Using this practice as a guideline, gage tolerance is always included in the part tolerance and accounts for up to 10%. This means that 10% of good product could potentially fail the inspection but that no bad product would ever pass.

3 Software application

A software application was created using the Visual Basic programming language, which enables to determine quickly the cylindrical plug or ring/snap gage dimensions, depending on the part being gauged.

A gage database was created, where are memorized all needed information (dimensions and tolerances, formula, drawings) for the cylindrical gage application.

The program gives the possibility to choose between gages that check the outside diameter of parts - ring or snap gages or the inside diameter - plug gages (fig.4).

So, if for instance we intend to design plug gages, a window like that presented in figure 4 will be opened.

Because the gages for cylindrical parts come in different types based on size and application, depending on the part diameter being gauged we must choose the gage type and introduce the part desired diameter.

Then, a new window will be opened (fig.5) and the standardized drawing will appear in the bottom. The figure 5 presents the drawings for a plug gage that check an inside diameter up to 30 mm.

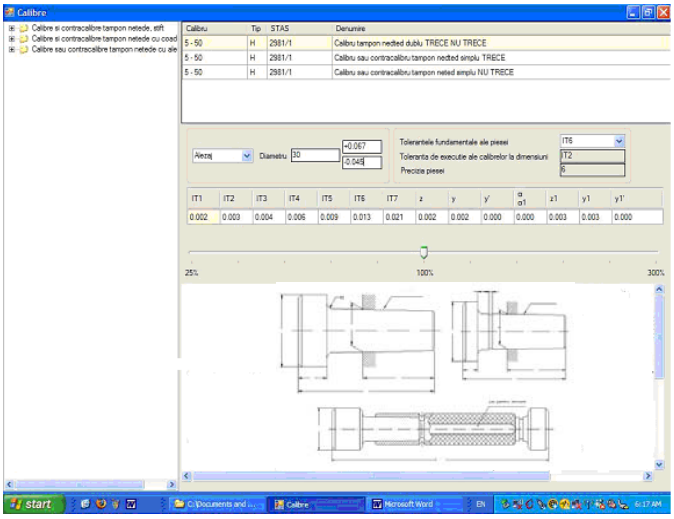

Fig.5

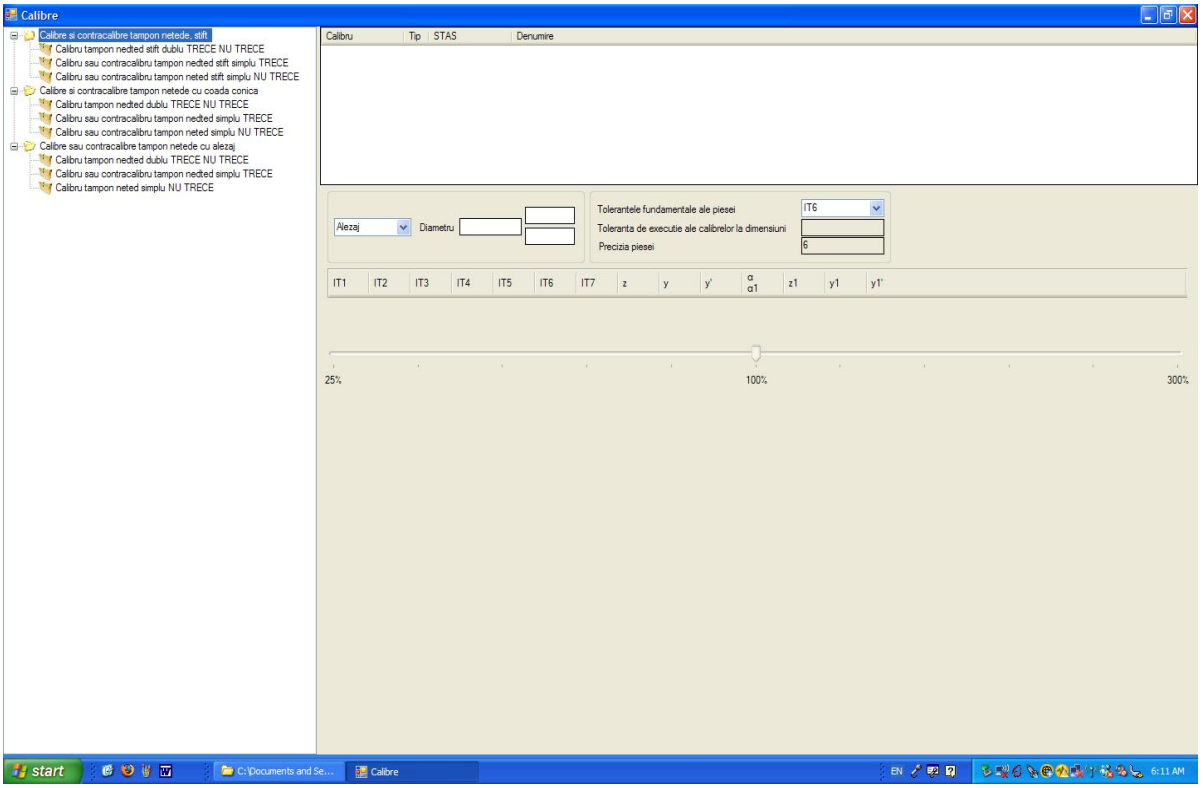

Fig.4

If we want to check a bigger hole diameter we must choose another gage type and introduce the part desired diameter; a new style of plug gage will appear in the bottom of the window. It is the same procedure if we want to check a shaft; for instance, the drawing for a ring gage may be as that presented in figure 6.

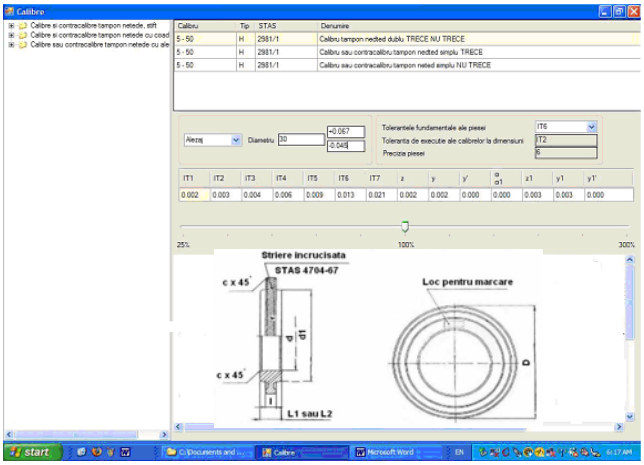

Fig.6

Database and standardized techniques of calculating the nominal sizes and limit values of gauges have been included in the program.

Until now, our software product is restricted for checking a blueprint dimension given for the cylindrical parts but in the future we intend to develop it for other kind of features.

Using this software application it is possible to calculate the dimensions for Go side, used Go side and NoGo side of all the plug gages and ring/snap gages, according to standard.

The calculated results are based on international standards and comprise detailed information about the sizes and tolerances of ring/snap and plug gages for cylindrical parts.

The program is especially useful in the design of gages since it saves time and costs fir carrying out calculations and providing standards.

The software assists users in the following types of activities:

- determining the nominal sizes and limit values of gages for cylindrical part inspection;
- drawing of gages for cylindrical parts.

4 Conclusions

This software application is a program designed for the students that are involved in our educational programs, but in the future, the database may be developed to be used by engineers, quality managers, mechanics, etc. in the IMPRO knowledge network from Romania and its purpose is to save time and to prevent personal errors in determining nominal and limit parameters of gages.

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