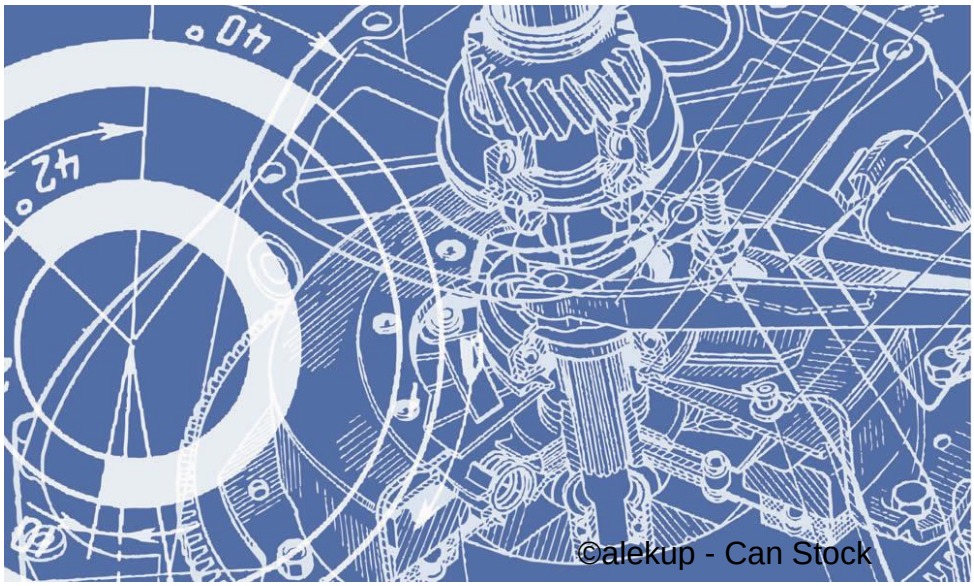


Building an unambiguous Product Drawing

Five steps to building a good and focused product drawing

A good well thought through product design can be negatively impacted by a drawing of low quality. The product drawing is the main, or at least one of the main documents, that determents the product quality. A not well prepared product drawing can result in long verification times, misleading interpretations of verification results, additional change loops etc. all leading to a higher product cost and possible delays and missed opportunities.

> *A good well thought through product design can be negatively impacted by a drawing of low quality*

Adding a lot of dimensions to your part drawing is **not** how you get good control of the product quality. Instead my advice is to make your drawing creation a focused process where you build the drawing using a structured process. This way you both ensure that the drawing is easy readable, it is unambiguous and the person that later will verify the product by measuring understand the drawing, know what is important and there is alignment on how to measure each dimension.

A prerequisite for creating superior drawings is of course knowledge of general drawing standards, I prefer the ISO standards, but national and ASME standard knowledge is almost a must when dealing with international suppliers. It is also important not to forget the Geometrical Dimensioning and Tolerance standards here. Both the drawing creator/product developer and the product supplier needs to have not only an understanding of these standards, but a common understanding. Otherwise there is a huge risk that the use of them will lead to misunderstandings.

> *The product developer always has the end responsibility for the drawing, even if a drafter supports creating it*

If the product developer does not make their own drawings, but has a drafter to do it for them, it should be remembered that the product developer is always responsible for the drawing, both its content and quality. I have unfortunately on many occasions seen product developers not paying enough attention to the creation of the drawings of their products, just because another person assisted them in making the drawing. Often these product developers ended up having a hard time getting their products measured and later approved. Often with a lot of changes to be done to the drawing. If you are working with drafters, make sure that the drawing creation is a combined effort and responsibilities are clear.

To support the development of creating drawings of high quality, I have created the following few steps;

1. Create the basic layout and fill the drawing header
2. Establish the Datum system
3. Dimension the features one by one
4. Get the drawing checked by a skilled reviewer
5. Review the drawing with the measurement specialist

In the following I will give more insight to each of the steps.

1. Create the basic layout and fill the drawing header

When creating the basic layout, choose the drawing size, e.g. A3, that you expect will be big enough to cover all the views and information you think will be necessary to describe your product. Be willing to increase/decrease the size later. One of the main issues making a drawing hard to read, is when too much information is squeezed into too little space

> *Choose a paper size that is big enough making sure the information is not squeezed in*

When the basic views, e.g. front, side and back views are laid out - at this point it is not necessary to start making sections and detailed views - fill in the drawing header with the appropriate information. Ensure you give a detailed material definition. It is an unpleasant surprise to discover that the material was wrong when holding the first parts in your hand, just because your material definition on the drawing was ambiguous, or the plastic molding tool was made with wrong shrinkage factor. Wrong or ambiguous material definition is one of the most common errors I see. If a data management system is used to pull standard data to the drawing header, ensure that it pulls the right information, if not, then change the information in the datamanagement system, not in the drawing.

2. Establish the Datum system

It can be debated, what datums should be used to form the datum system of the drawing. I think, most prefer that it is the main features, e.g. for mating to other parts, that is forming the datum system. Others prefer that it is the features that will be used for retaining the product during measurement. My experience is, that it often ends up in a combination of these. The bottom line is, that those using the drawing later, must be able to read, understand and use the Datum system. You might even need to establish 2 or more datum systems on the drawing. Be prepared to add/change datum systems as you go along building the drawing.

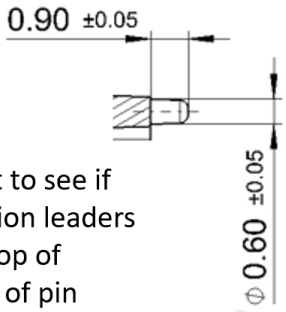
3. Dimension the features one by one

Focus on one feature or interface at a time, instead of adding dimensions randomly on the drawing. Have your tolerance calculations on hand. Make views, cross sections and detailed views as needed during this step.

When adding a dimension, always ask yourself these questions:

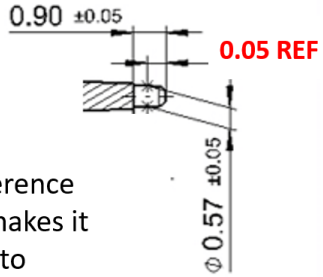
- **Is this dimension necessary and what control of the quality does the dimension give?** Evaluate each dimension on the need to control that specific dimension. What will happen if we do not verify the dimension? Can we be sure that the dimension will be inside specification with normal care to the manufacturing process? If the answer is yes, then it might not be needed at all.
- **How can the dimension be added so that it ensures unambiguity?** It can be difficult to add a dimension to a feature in a clear way, so that it cannot be misinterpreted what edges on the product it refers to. An example on this and a possible solution is shown in the picture below.

Ambiguous



Difficult to see if dimension leaders are to top of bottom of pin

Unambiguous



Use of a reference dimension makes it clear where to measure from

- **How can it be verified/measured?** Think about how the dimension is to be measured. Is it necessary to cut the item, then it might not give much sense at all, or you will need to encapsulate the part in epoxy or similar before you cut or grind to be able to measure with higher accuracy. Simply because the cutting can add too much uncertainty to the measuring compared to the size of the tolerance.

> *Dimensions that requires cutting for verification are seldom a good idea*

- **Is the tolerance added to the dimension applicable?** Tolerances should be verified by tolerance analysis or statistical data from similar product/materials. It should also be remembered, that the tolerance stated for a given dimension is build up by contributions from various sources, and not only the part itself, e.g. part-to-part, tool-to-tool, cavity-to-cavity variation, manufacturing and measurement accuracy.

4. Get the drawing checked by a skilled reviewer or peer

Always have a skilled reviewer/peer to review and approve your drawing. If your company has ISO certification, this should not be new to you. Make sure that the reviewer uses the necessary time to look through and understands the drawing. The more errors and ambiguity the reviewer finds, the better as it will save you much pain during verification. And even better - check the drawing content with a peer or reviewer during the creation of the drawing, and not when you have it finalized. It will save you and the reviewer time in the end and improve the drawing quality.

A good hint; Do the development of the drawing in iterations, on printed paper, rather than directly in the CAD system. This is especially helpful when the drawing is made in cooperation with a product developer, a drafter and a reviewer. Sit around a table with the printed drawing and add views, notes, dimensions etc. by

hand as you discuss the interfaces one by one. Make it in smaller sessions of 30-60 min. and update the drawing in the CAD system and print a new version for the next session.

> *See the drawing as a cooperation between the designer, a reviewer, manufacturer and the measurement specialist*

5. Review the drawing with the measurement specialist

When the drawing is finalized, make a final review with the person that is going to verify the product quality by measuring or testing. Ensure that you all read the drawing the same way, that you have the same understanding about how each dimension is to be measured, how the product will be retained during measurement, what the accuracy of the measurement method is, how the result is reported and finally, a shared expectation of how much of the tolerance field can be used (to ensure space for production variation). You will probably here find some dimensions or tolerances that needs to be changed or removed. Simply because it is not possible to measure within an appropriate accuracy. As stated earlier, it makes no sense to measure a dimension if the measurement systems accuracy is worse or close to the tolerance span of the dimension.

My own results using a structured drawing development method is among other;

- Increased product quality by use of less dimensions.
- Significant reduction of time for verification, by reducing the amount of correction rounds, time for measuring and discussions of dimensions with the supplier.
- Reduced time from first measuring report to a full part approval down to few days for copy tools (multiple injection molds for same product).

Not to mention the direct cost savings derived from better quality and reduced time to market caused by a smooth part verification and approval.

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