巻頭言

清浄なるもの

The Two Meanings of *Seijo* (清浄)

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I will never forget the time we were criticized by one of the top managers of a company we had ordered a prototype of a refrigerant tank from. The reason was a note we had made on the blueprints we had sent the maker, which said that the inside of the tank "be clean," or "*seijo*" in Japanese. "Do you guys even know the meaning of *seijo*?" he asked us sharply. In traditional Japanese mathematical notation based on the Chinese system that uses Chinese characters rather than numerals to signify the fractions from $1/10^{th}$, $1/100^{th}$, $1/1000^{th}$ and downward, the 21^{st} and last in the order of diminishing fraction is represented by the characters *seijo*(清浄). In other words, *seijo* is the equivalent of 1×10^{-21}. Unaware of this fact, we had simply used the word *seijo* in its common, non-mathematical meaning of clean, or free of dirt. That is what had annoyed the maker's manager so much. "Writing *seijo* on the blueprint is the same as saying that you want dimensions with a margin of error of virtually zero," he complained. Of course, by writing *seijo* we had only intended to ask the inside of the tank be cleaned of any metal shavings or the like. However, having learned the mathematical meaning of the word, we realized that it had not been a good choice of expressions.

Although in our work we would never do anything as outrageous as demanding a margin of error in the range of 21 digits below the decimal point, there are times when we needlessly use notations that imply an unreasonably low margin of error or dimensional tolerance and demand levels of precision that are virtually impossible in the real world of manufacturing. And, in fact, the loss and waste resulting from these unreasonable demands is quite large. The end result is an immediate rise in cost. This is why we have to be more aware of the actual meaning and consequences of the numbers we use. We have to think of numbers as living quantities and use them with the care they deserve.

Returning to the original story about that prototype tank we ordered, if it is a one-liter tank that means that the air inside it contains approximately 2.5×10^{22} molecules of nitrogen and oxygen, etc. If our original note on the blueprints saying the inside of the tank "be *seijo*" were taken in its mathematical implication of a margin of error, that would mean a debris tolerance on the level of 25 molecules of its air content. And it just happens that that is about the level of precision possible in the world of science today.

Now, consider this proposition. Of course it is purely hypothetical, so it can be taken with a grain of salt. It can be said that the folding a sheet of newspaper 100 times would theoretically produce a thickness that would exceed the breadth of our galaxy. If a sheet of newspaper has a thickness of 0.1

mm and folding it once produced a thickness of 0.2 mm and folding it twice produced a thickness of 0.4 mm, then doubling that thickness 100 times would equal a distance that extends out of our galaxy. It is indeed true mathematically that 0.1 mm $\times$ 2^{100} $\fallingdotseq$ 1×10^{26} m $\gg$ 1×10^{16} m (diameter of our galaxy: 100,000 light years). This would be the calculation for the hypothetical height 100 folds would produce, but what would the width become in the process of that folding? If we say that a sheet of newspaper is approximately one meter square, the calculation for the width would be 1×10^{-30} m. In other words, while the 100 folds produced a theoretical height that would extend outside the galaxy, the width of that sheet of newspaper would be reduced to a size much smaller than that of an atom (approx. 1×10^{-10} m). Since even a quark is 1×10^{-17} to 1×10^{-18} m, the theoretical width of 1×10^{-30} m is impossibly small in the present world of science.

In mathematics there are no limits to the size or smallness of numbers, but in the present world of science to limit of length is believed to be the breath of the universe (13.8 billion light years), while the limit of smallness is the length of a quark (1.6×10^{-35} m). In the world of science there are physical limits to size.

Doesn't this mean that when dealing with things or situations, we need to avoid pursuing the ultimate or the infinite? Doesn't it mean that we need to avoid setting goals that are meaningless or impossible?

While it would be nice if we could live a life of the kind of clean and faultless purity implied by the ancient Chinese concept of *seijo*, at least we should try to avoid being so innocent that we are unaware of the consequences of the demands we make.

かつてこんなことがありました。冷媒用タンクの試作図面をメーカーに出したところ、先方の役員の方から「おまえ達は“清浄”とはどんなことか知っているのか！」と激しくお叱りを受けました。注記欄に『タンク内は清浄なること』と書いてあったことに対してでした。「“清浄”とは日本、中国で小さな数字を表す『一、分、厘、糸、・・・・刹那、六徳、虚空、清浄』の最後に来る最も小さな数である。おまえ達は寸法公差が限りなくゼロの図面を平気で書いているのと同じである。」というのです。調べてみると、確かに小さな数字の最後に“清浄”という単位があり、1×10の-21乗を表すとのことでした。勿論こちらはそこまでの見識も意図もなく、「タンク内に切り粉などを残さないように洗浄しておいて下さい。」という程度のつもりであったのですが、意味を知ってみれば、表現として不適切であったと謂わざるをえませんでした。

寸法公差を入れるにあたって、ここまで無神経なことはしないでしょうが、そこまで必要ない公差を無意味に書き入れたり、作れもしない精度を要求したりしていることがあります。そのために発生するロス、無駄は過大です。結果、すぐにコストに跳ね返ってきてしまいます。数字の持つ意味、影響を常に考えて、生き物である数字を丁寧に扱って行かなければなりません。

上述の話に戻ります。タンクの内容積を1リッターとすると、その中には、2.5×10の22乗個の窒素や酸素分子が入っています。「清浄なること」という注記は、空気の構成分子レベルで25個分までのゴミを許容すると記していたことになります。たまたまですが、これは科学の世界でもまだ辛うじて成り立ちます。

では、こちらの話はどうでしょう。所詮仮定の話ですので、目くじらを立てるのは大人げないところもあるのですが。「新聞紙を100回折ると、その高さは銀河系直径を超える」という話です。仮に新聞紙の厚さが0.1mmとして、1回折ると倍の0.2mm、2回折ると0.4mm。以下、倍倍で高くなって行き、100回目になると銀河系の果てを越えてしまうというのです。確かに、0.1mm×2の100乗≒1×10の26乗m≫1×10の16乗m（銀河系の直径：10万光年）となります。高さ方向にはこのようになるのですが、一方の幅はどうなるのでしょうか？新聞紙の縦横を1m前後として、およそ1×10の－30乗mとなります。つまり高さ方向では銀河系の外まで行ってしまいますが、その場合の新聞紙の幅は、原子の大きさ（1×10の－10乗m程）をはるかに下回ってしまいます。クォークでも1×10の－17～－18乗mですので、このときの幅は、科学の世界ではありえない小ささなのです。

数字の上ではいくらでも大きな数、いくらでも小さな数はありますが、現在の科学の世界では、長さの単位として、大きいものには『宇宙の果て（138億光年）』という限界があり、小さいものでは、プランク長（1.6×10の－35乗m）が限度とされています。科学の世界では、あくまで有限の果ては有限なのです。

モノ、コトにあたるにおいて、無限の追求は避けなければなりません。無意味なもの、不可能なものを目標にしてはいけないということでしょうか？

『“清浄”なる人生を！』と願うところですが、まかり間違っても“無垢”だけは目指さないことを心して。

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