

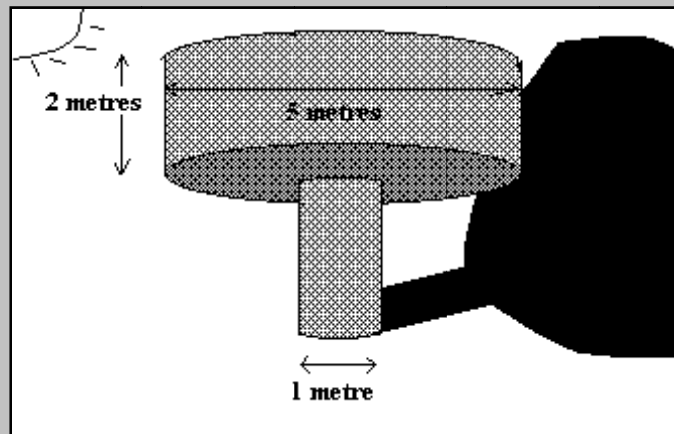
Proportions are more than perspective

Scaling up or scaling down sometimes puts us out of proportion, says S.Ananthanarayanan.

Shrinking or enlarging an article often needs changes in shape, not just size.

Squares and cubes

The reason that this happens is because strength of things depends on the cross section area, but their weights depend on their volume. Hence, if the dimensions of an article were just increased in equal proportions, then, the strength of its components and the weights to be carried need not increase to equal extents.



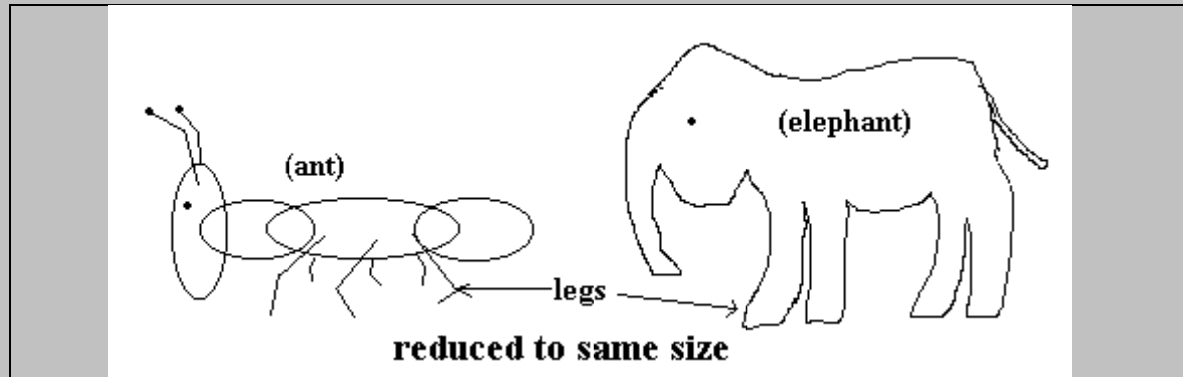
An example can be a water tank supported by a column, like in the picture. If the dimensions are doubled, then the diameter of the column goes from 1 metre to 2 metres. As the strength of the column depends on the cross-section area, the strength increases by a factor of $2 \times 2 = 4$.

But the diameter of the tank and its height also get doubled. The cross-section area is increased from $2.5 \times 2.5 = 6.25$ square meters to $5 \times 5 = 25$ square meters, a factor of 4, and the height also increases by a factor of 2. Hence, the volume increases by a factor $4 \times 2 = 8$! This means the load per unit area of the supporting column is now twice what it was. If the dimensions were increased in direct proportion, like this, the column would soon give way and the tank would come down.

Animals and limbs

The need for supports to get more than proportionately thicker as the size increases is illustrated in the limbs of animals. Take an ant, or a fly, which are just about a centimeter in dimensions. The legs of these creatures are less than a fourth of a millimeter in diameter. The diameter of the legs is thus about 40 times less than the dimensions of the animal.

Now let us consider a man, about 2 metres tall. The diameter of his feet, in the same proportion as the fly, should be one fortieth, or just 5 centimetres. This is 2 inches. We know well that a six foot hulk has thicker legs than that! Now consider an elephant, dimensions about 4 metres. In proportion, the legs should be about twice as thick as a man's, or even less, because elephants stand on 4 legs. But we know that elephants' legs are much thicker.



At the other end of the scale, we have tiny, microscopic insects, less than a millimeter in size, 'ant-sized' even in comparison with an ant. The limbs are almost invisible! And when we go even lower down in the scale, the dimensions get comparable to the molecules themselves of the air, and limbs do not make sense any more.

Gulliver's travels

In Jonathan Swift's Gulliver's Travels we meet the people of Lilliput and Blefescu, people only 6 inches tall. In popular illustrations, these people are shown to be scale models of ordinary people, leading a lifestyle exactly like in our own towns and villages. But we know that this scaling down is not actually true. Lilliputians would have thinner legs and they would be able to carry heavier loads, compared to their own weight, than ordinary people. Their lifestyle, their fashions and economy would be quite different.

Swift's classic was a parody to show how our own ways appear petty when viewed in perspective. Scientists also study communities of insects and microbes to connect with the behaviour of human populations. But the parallels often do not hold, because value systems get upset with changes in dimensions.
