User study: human beings' preferred views for a box.

We conducted a user study to validate our observation that the ratios between the length, width, and height of a box can be well preserved by their projections in a canonical view of the box. In this study, we invited 16 participants, and asked them to manually select their best views of 20 boxes in different lengths, widths, and heights. Then, for every box, we measured its projected length, width, and height in the selected 16 best views, and used their averaged values as the projected length, width, and height of the box in a canonical view. Table A lists the boxes and their related ratios, where *Original ratio* denotes *L: W: H*, and *Projection ratio* denotes *l: w: h*.

Afterward, we checked whether the ratios between the length, width, and height of the boxes were well preserved by the corresponding ratios in their respectively selected canonical views. To accomplish this, we computed the Pearson product-moment correlation coefficient (referred to as the PPMCC) [1], denoted as *pr*. This is a widely used scientific measure of the degree of linear dependence between two variables. The formula for computing *pr* is as follows:

$$pr(X,Y)=\frac{\sum_{i=1}^{n}\left(X_i-\overline{X}\right)\left(Y_i-\overline{Y}\right)}{\sqrt{\sum_{i=1}^{n}\left(X_i-\overline{X}\right)^2}\cdot\sqrt{\sum_{i=1}^{n}\left(Y_i-\overline{Y}\right)^2}}$$

where X_i and Y_i are samples of two variables, and n is the number of samples. In our study, we used one of the ratios between the length (L), width (W), and height (H) as a variable, and the corresponding ratio between their projected length(l), projected width (w), and projected height (h) as another variable, to check whether their ratios are strongly correlated. The ratio statistics are plotted in Figure 1, where it is clear that the plotted points are distributed very near the diagonal line, indicating that the ratios between the length, width, and height are well preserved by the projected length, width, and height in the selected views. By the PPMCCs for the ratios, $pr(l : w, L : W) = 0.9830$, $pr(l : h, L : H) = 0.9770$, and $pr(w : h, W : H) = 0.9830$, it is shown the corresponding ratios are strongly correlated; therefore, our observation is validated.

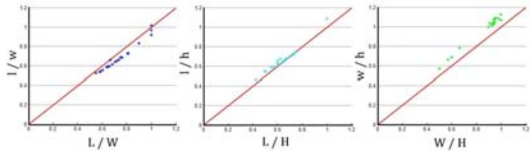
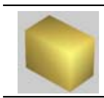
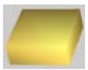
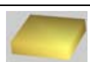
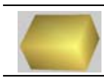
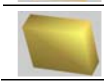


Figure 1. Correspondence between the ratios of the edges of the tested boxes and the ratios of the projected box edges in the selected views in Table A.

Reference

1) K. Pearson. Note on regression and inheritance in the case of two parents. In *Proceedings of the Royal Society of London*, volume 58, pages 240–242, 1895.

Table A. The ratios between the edges and between the projected edges of the tested boxes.

Boxes	Original ratios*	Projection ratios#	Boxes	Original ratios*	Projection ratios#
	1 : 1 : 1	1 : 0.98 : 0.92		1 : 1 : 3	1 : 1.08 : 2.71
	1 : 2 : 3	1 : 2.34 : 2.7		1 : 0.67 : 1	1 : 0.72 : 0.97
	1 : 1.33 : 1.67	1:1.42:1.42		1 : 5 : 1	1 : 4.22 : 1.02
	1 : 5 : 6	1 : 5.93 : 5.51		1 : 1.06 : 0.39	1 : 1.4 : 0.49
	1 : 0.96 : 0.24	1 : 1.12 : 0.26		1 : 4.19 : 8.06	1 : 5.9 : 9.51
	1 : 0.34 : 0.67	1 : 0.34 : 0.62		1 : 1.27 : 1.37	1 : 1.49 : 1.97
	1 : 0.25 : 0.27	1 : 0.33 : 0.34		1 : 3.26 : 0.99	1 : 4.27 : 1.62
	1 : 0.3 : 1.14	1 : 0.28 : 0.89		1 : 0.56 : 0.72	1 : 0.68 : 0.83
	1 : 0.77 : 0.57	1 : 0.88 : 0.72		1 : 0.7 : 0.66	1 : 0.81 : 0.8
	1 : 0.31 : 0.83	1 : 0.33 : 0.74		1 : 0.71 : 6.99	1 : 0.68 : 5.93