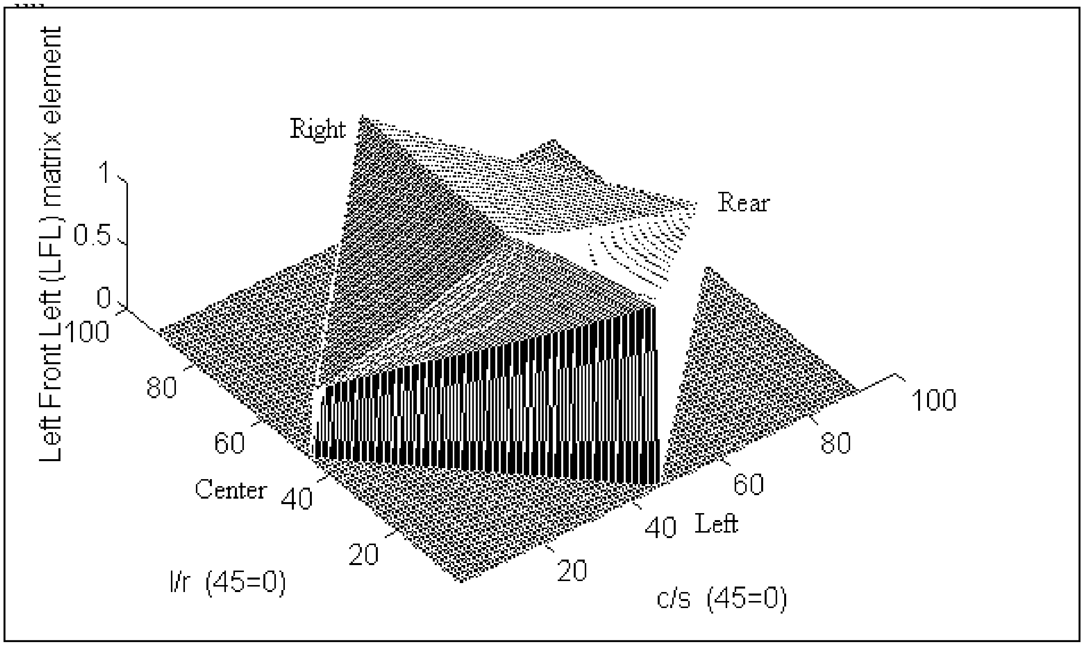

Figure 1: The LFL matrix element from the ’89 patent and Dolby Pro-Logic, scaled so the maximum value is one. Note the matrix element consists of simple intersecting surfaces. The value is 0.71 in the center of the plane, and rises to one at the left vertex. The values at Rear and Center are 0.5.

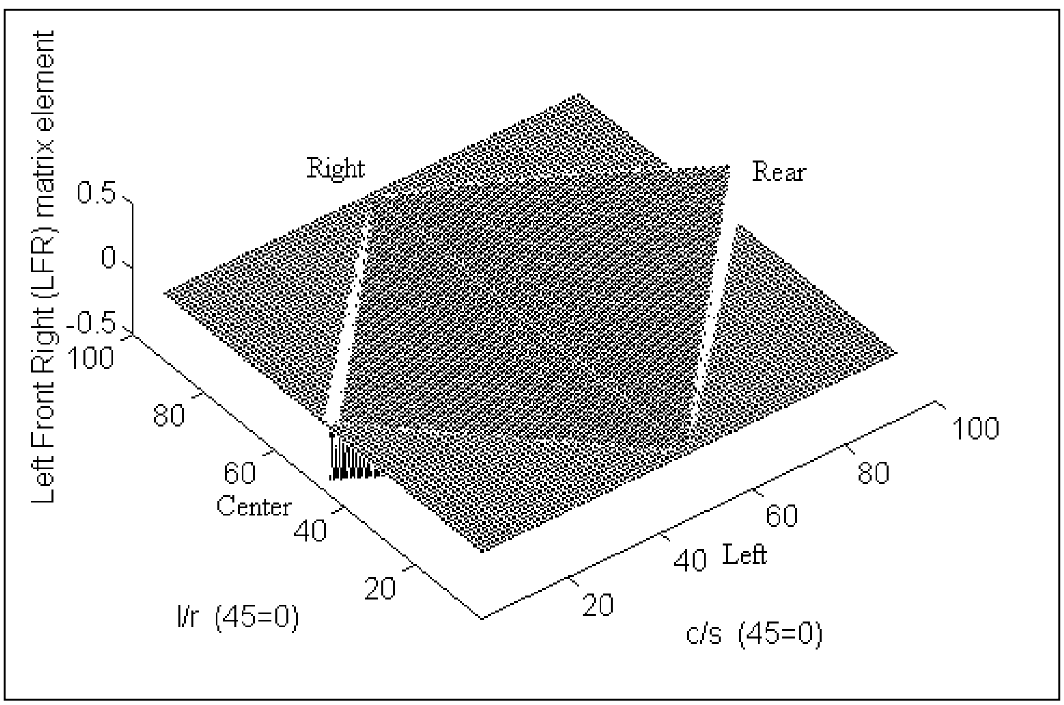

Figure 2: The lfr matrix element from the ’89 patent and Dolby Pro-Logic, scaled similarly to figure 1. The minimum value and max value is +-0.5. Note that at the center and rear vertexes the value here when combined with the values in the matrix element in figure 1 will cause exact cancellation of a strongly steered signal. Complete cancellation also occurs for signals that follow the boundary trajectory for positive values of lr – in this drawing the trajectory from center to right, and from right to rear.

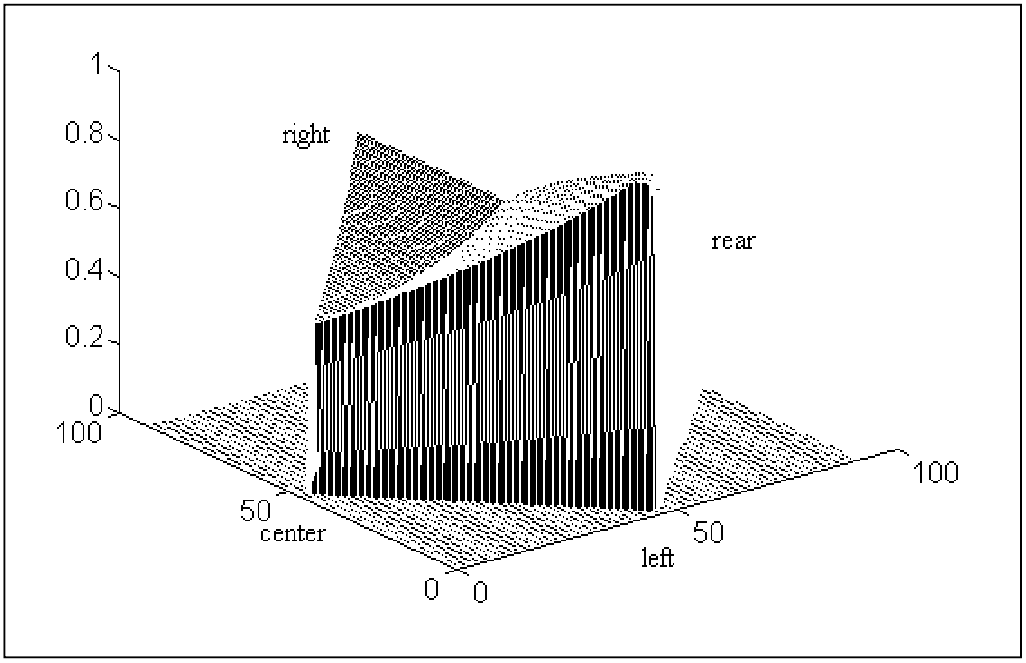

Figure 3: the square root of the sum of the squares of lfl and lfr from the '89 patent, scaled so the maximum value is one. Notice that the value is constant at .71 along the axis from unsteered to right. The unsteered to left rises 3dB to the value one, and the unsteered to center or to rear falls by 3dB to the value 0.5. The rear direction is identical to the center direction.

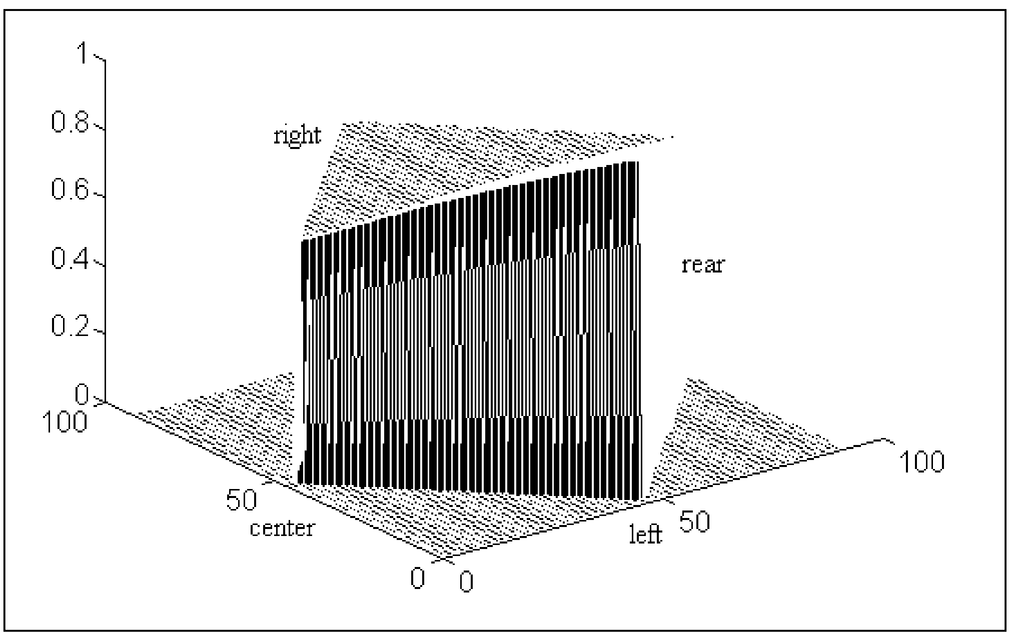

Figure 4: The square root of the sum of the squares of the lfl and lfr matrix elements from the AES paper, scaled so the max value is 1. Note the constant value of .71 in the entire right half of the plane, and the gentle rise to one toward the left vertex.

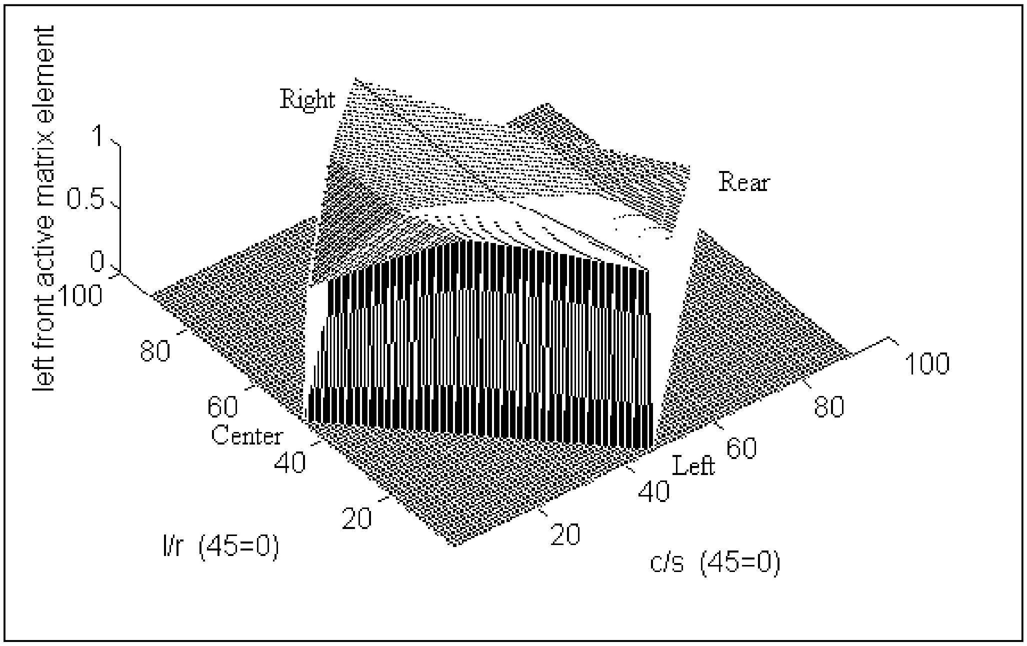

Figure 5: The Left front left matrix element in March of 1997. Note that the boost as the steering moves toward center is applied both along the lr=0 axis, and along the left to center boundary. Note also the reduction in level as the steering moves to the rear.

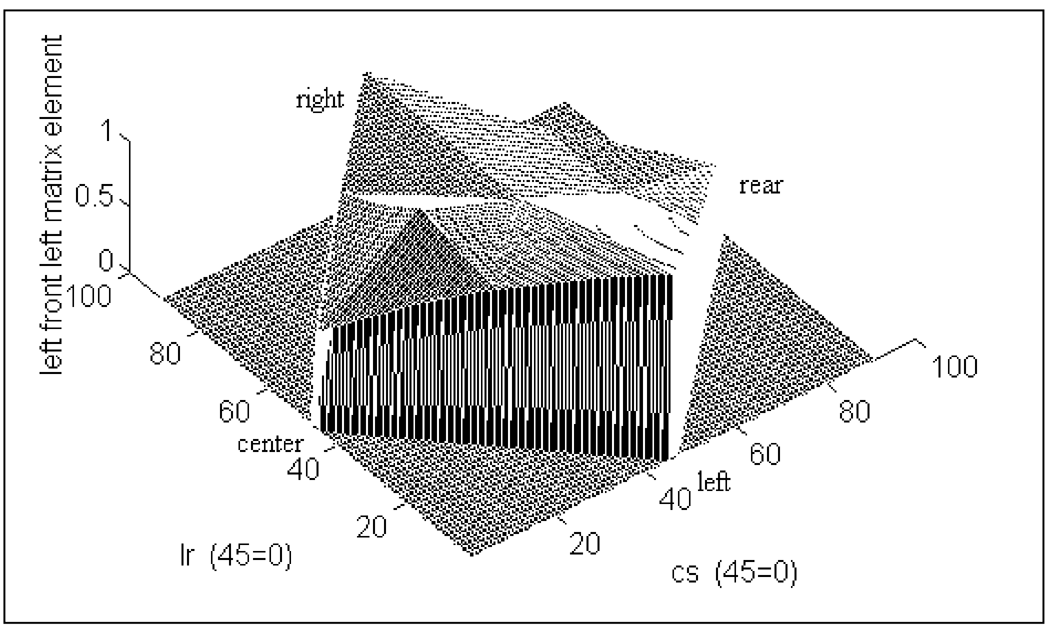

Figure 6: The new left front left matrix element has the correct amplitude along the left to center boundary, as well as along the center to right boundary.

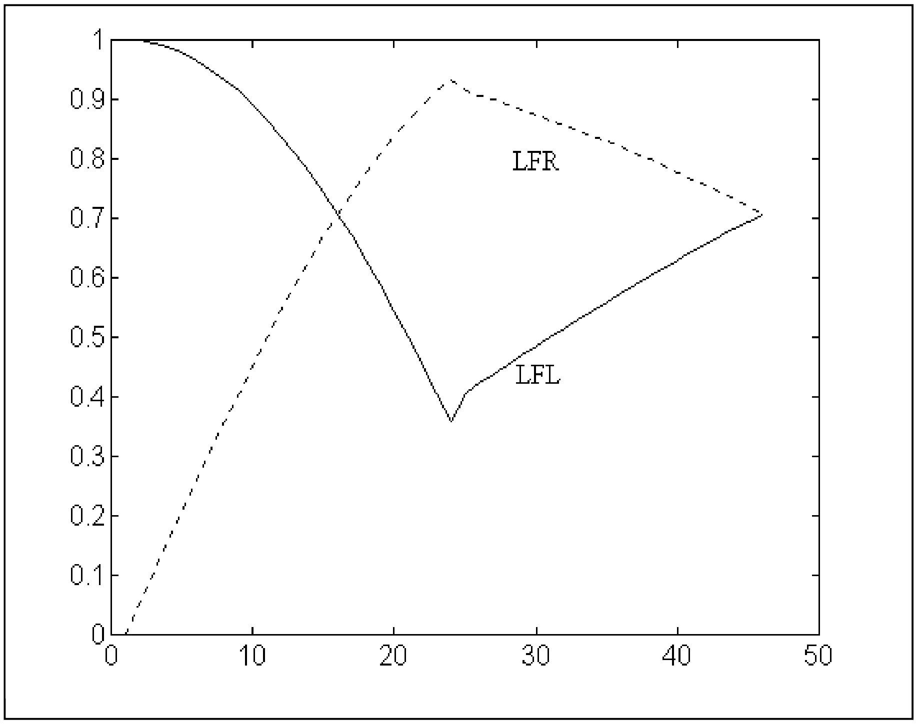

Figure 7: The behavior of LFL and LFR along the rear boundary between left and full rear. (The slight glitch is due to the absence of a point at 22.5 degrees.)

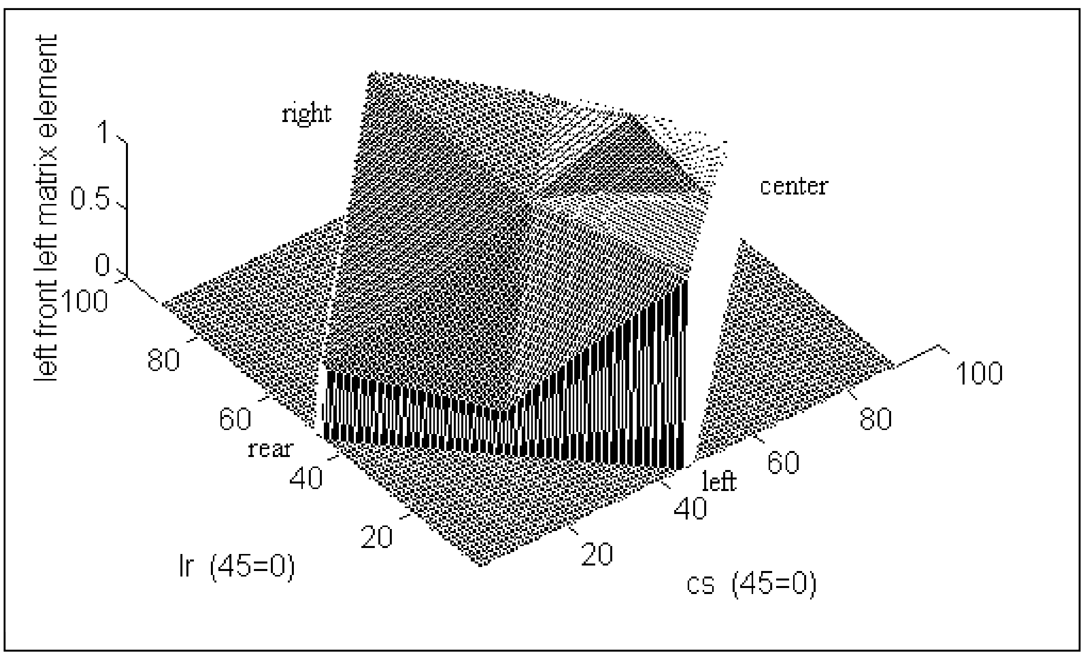

Figure 8: The left front left matrix element as viewed from the left rear. Note the large correction along the left-rear boundary. This causes the front left output to go to zero when steering goes from left to left rear. The output remains zero as the steering progresses to full rear. However, along the lr=0 axis and in the right rear quadrant the function is identical to the '89 matrix.

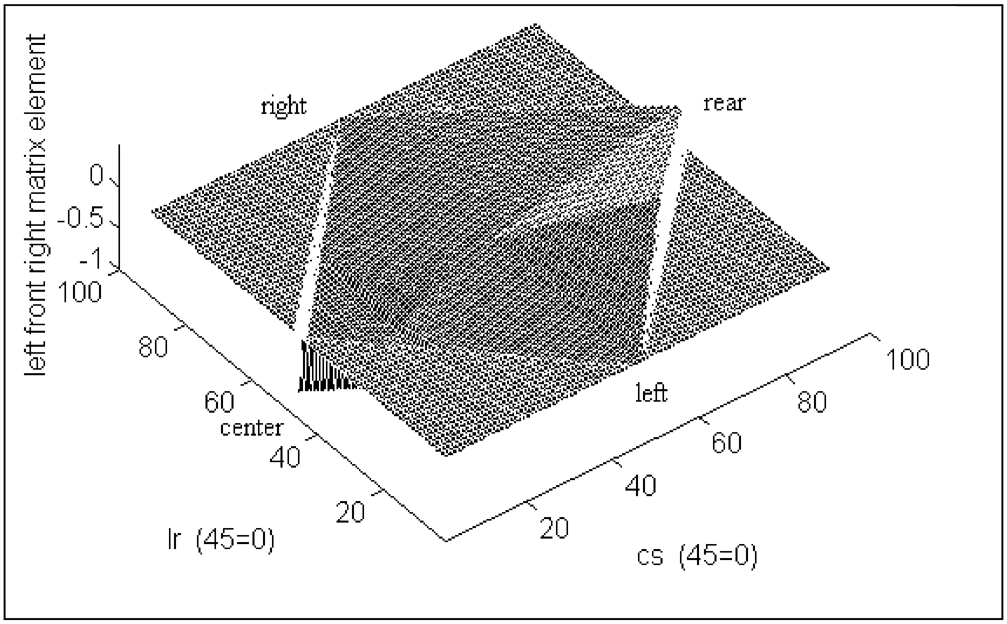

Figure 9: the left front right matrix element. Note the large peak in the left to rear boundary. This works in conjunction with the lfl matrix element to reduce the front output to zero along this boundary as steering goes from left rear to full rear. Once again in the rear direction along the lr=0 axis and in the rear right quadrant the element is identical to the '89 matrix.

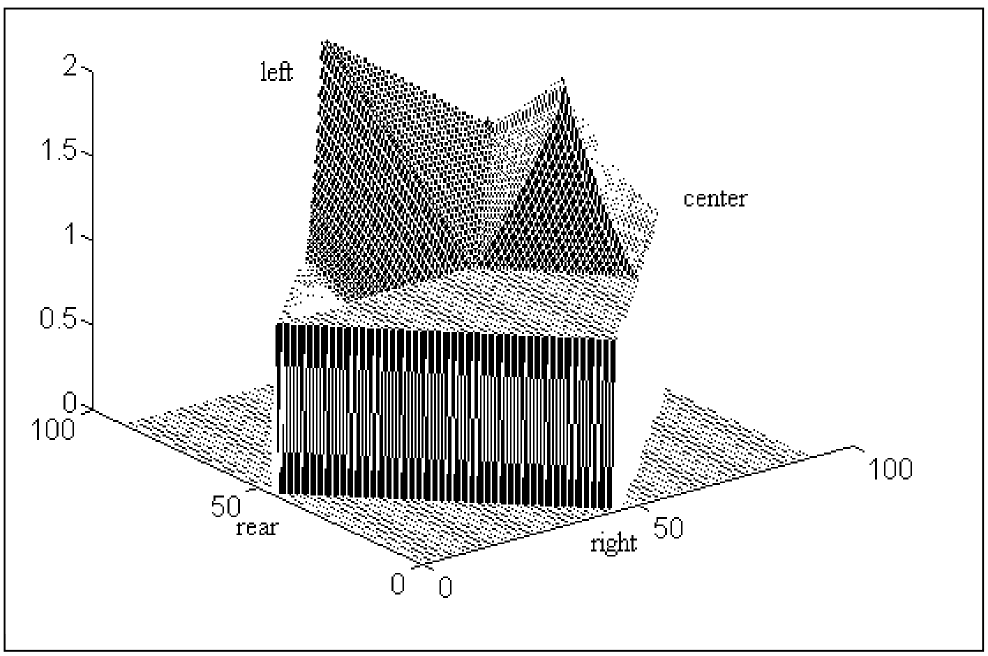

Figure 10: The squared sum of lfl and lfr, using the new design. (For this plot we deleted the 1/(sin(cs)+cos(cs)) correction in the rear quadrant, so we could see how accurately the resulting sum came to unity.) Note the 3dB peak in the left direction, and the somewhat lesser peak as a signal goes from unsteered to 22.5 degrees in the center direction. This second peak is a result of the deliberate boost of the left and right outputs during half-front steering. Note that in the other quadrants the sum is very close to one, as was the design intent. The value in the rear left quadrant is not quite equal to one, as the method used to produce the elements is an approximation, but the match is pretty good.

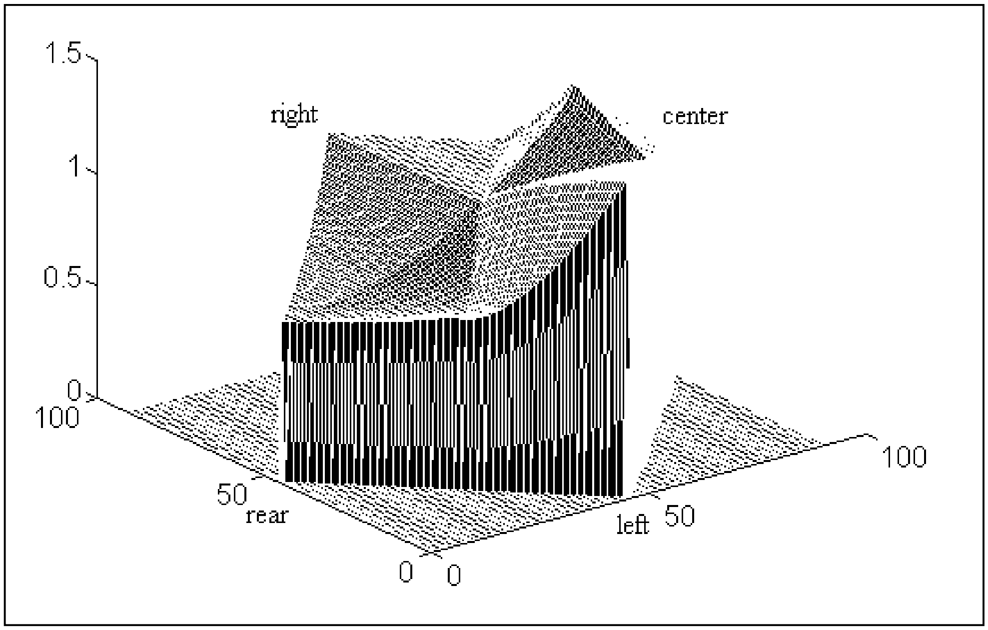

Figure 11: The square root of the sum of the squares of lfl and lfr including the correction to the rear level. Viewed from the left rear. The unsteered (middle) to right axis has the value one, the center vertex has the value .71, the rear vertex has the value 0.5, and the left vertex has the value 1.41. Note the peak along the middle to center axis.

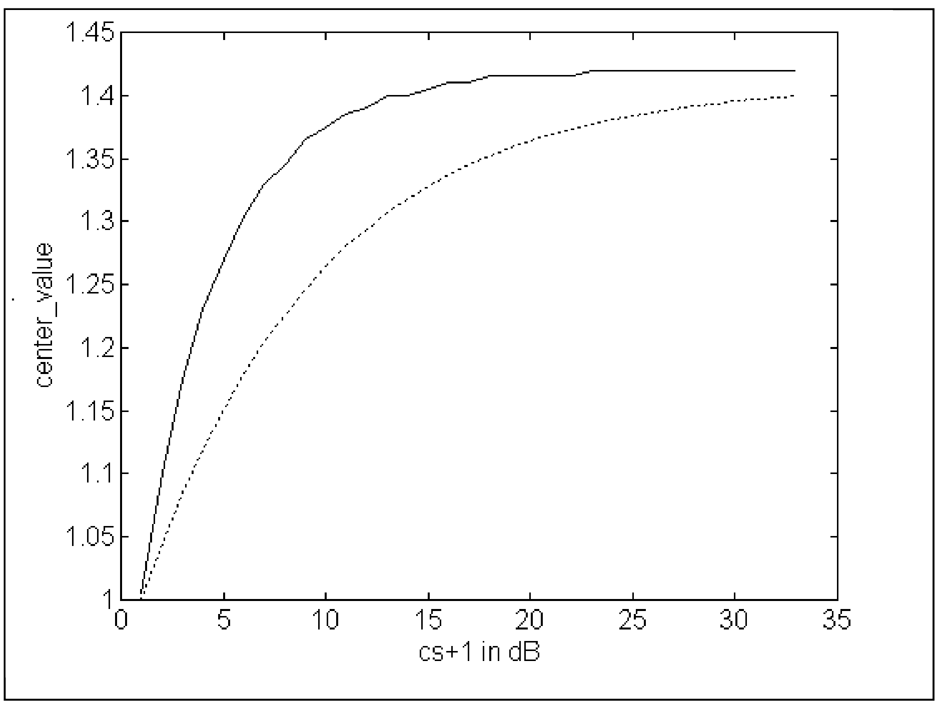

Figure 12 - solid curve, the center matrix value as a function of CS in dB, assuming sound power ratios identical to stereo, and using Dolby matrix elements with 3dB less power in the rear than typically used. The dotted curve is the actual value of the center matrix elements in Pro-Logic. Notice that while the actual values give reasonable results for an unsteered signal and a fully steered signal, they are about 1.5dB too low in the middle.

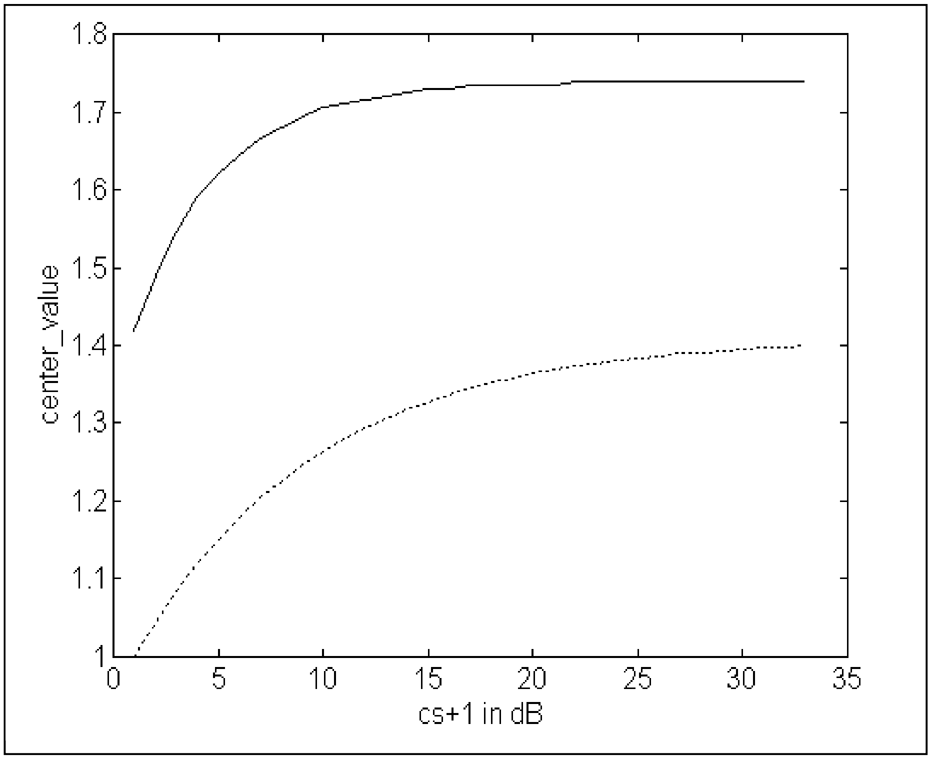

Figure 13: Solid curve – the value of the center matrix elements needed to produce equal center power as a stereo playback, given the matrix elements and calibration used in Dolby Pro-Logic. Dotted curve – the actual values of the center matrix elements in Pro-Logic. Notice that the actual values are more than 3dB too low for all values of cs.

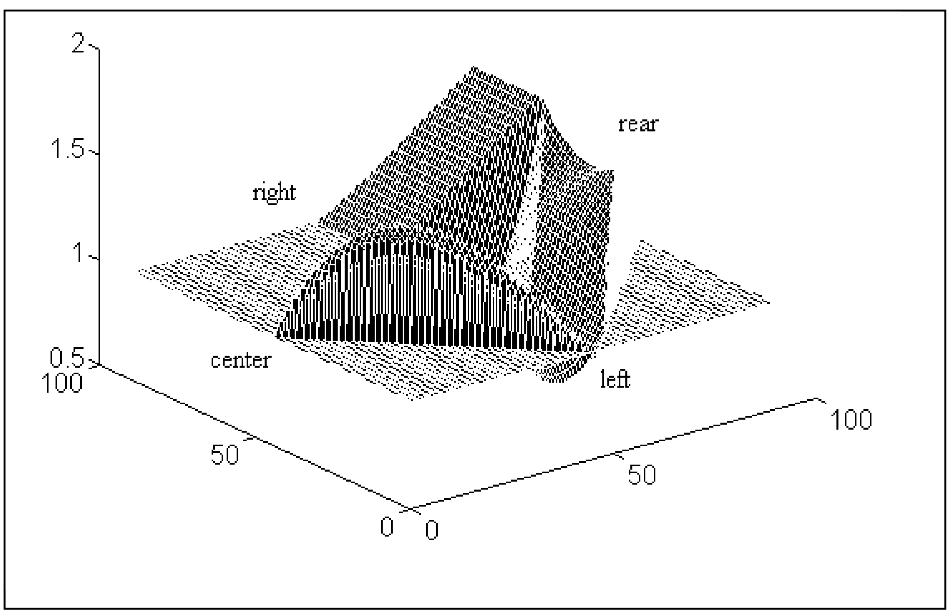

Figure 14: The square root of the sum of the squares of LRL and LRR, using the elements of March 1997. Notice that in the front left quadrant there is a 3dB dip along the line from the middle to the left vertex, and nearly a 3dB boost in the level along the boundary between left and center. The mountain range in the rear quadrant will be discussed later. This drawing includes an “unsteered” dip of 3dB at the center of the plane, which is hard to see in this projection.

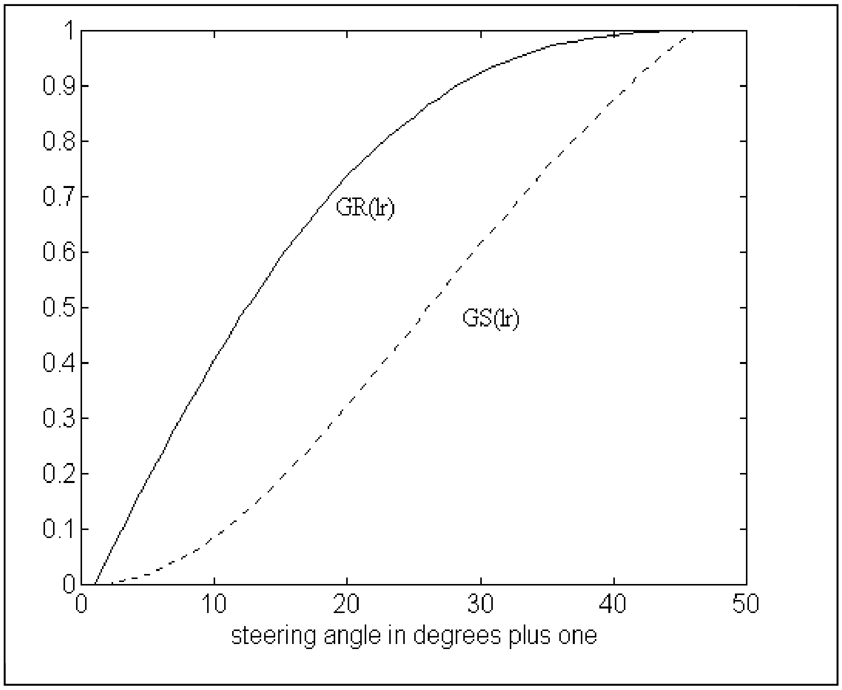

Figure 15: the numerical solution for GS and GR for constant power level along the cs=0 axis, and zero output along the boundary between left and center

.

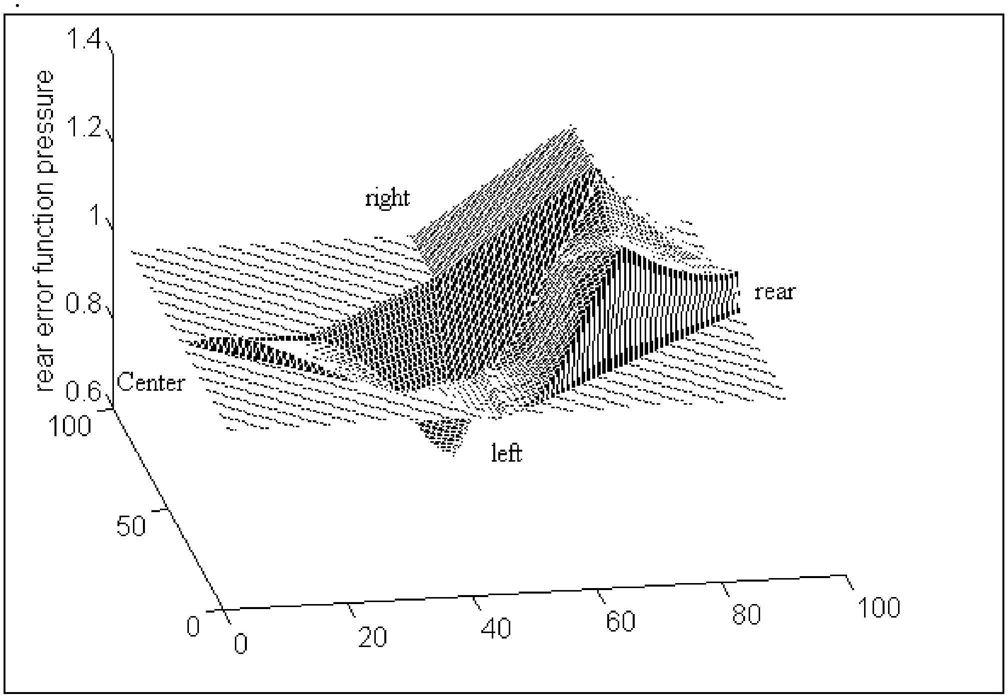

Figure 16: The square root of the sum of the squares of LRL and LRR using the new values for GR and GS. Note that except for the valley created by the “tv matrix” correction, the sum of the squares is close to one and continuous.

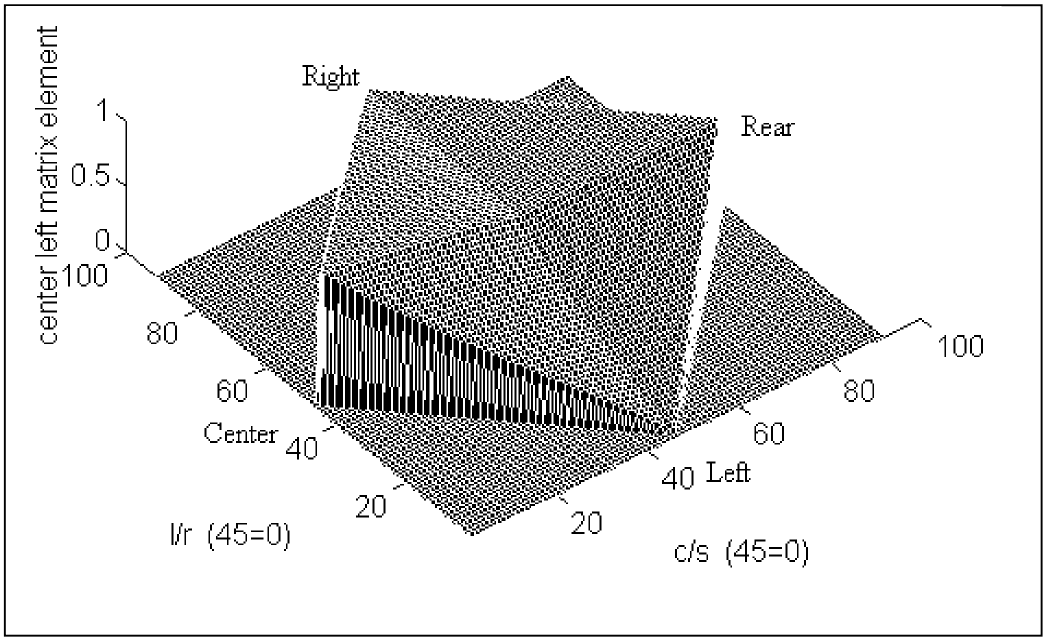

Figure 17: The Center Left matrix element in the '89 Patent (and Pro-Logic). The value at the center of the plane, the right vertex, and the rear vertex is .71, and the value rises to one at the center vertex.

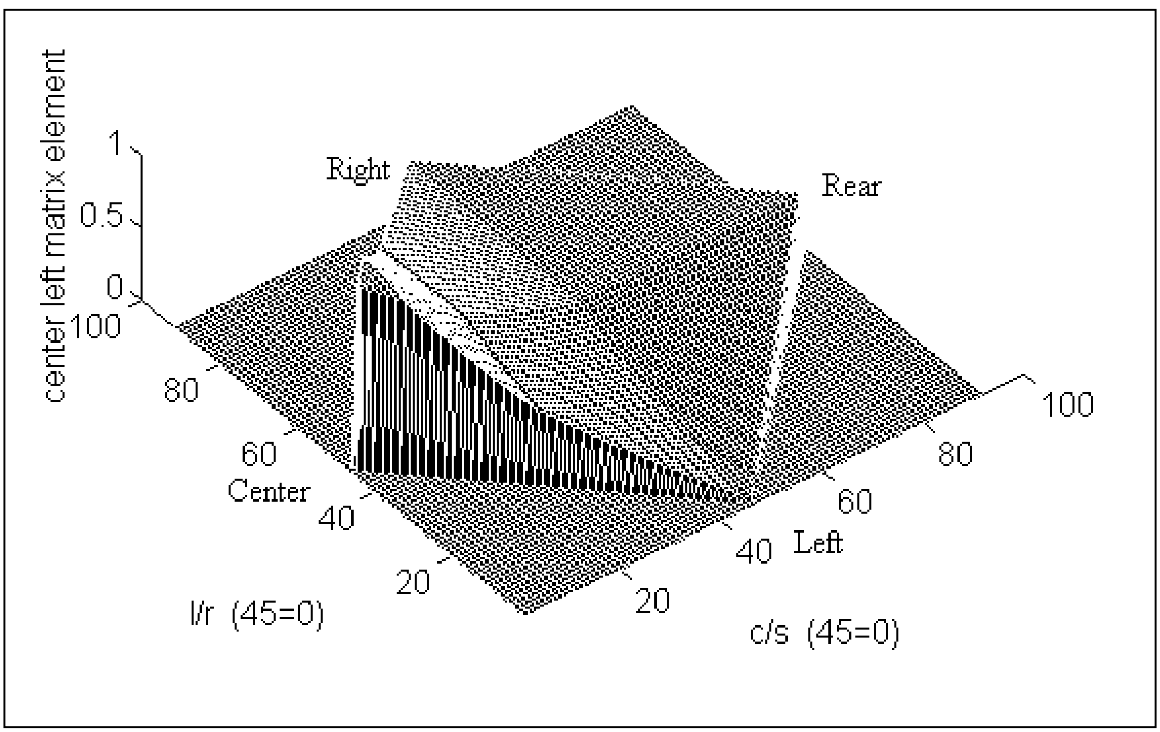

Figure 18: The Center Left matrix element in the March 1997 version of Logic 7. Note the middle value and the right and rear vertices have been reduced by 4.5dB. As cs increases the center rises to the value of 1 in two slopes. Compare this picture to Figure 17.

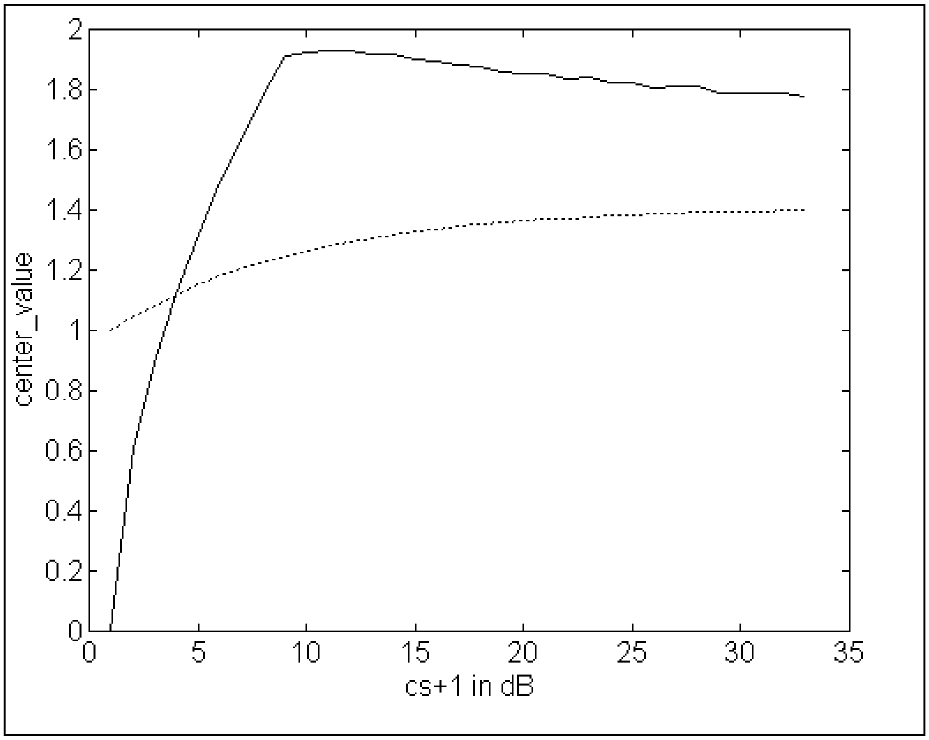

Figure 19; Solid curve - the center output channel attenuation needed for the new LFL and LFR if the energy of the center component of the input signal is to be preserved in the front three channels as steering increases toward the front. Dotted curve – the center values for a standard decoder

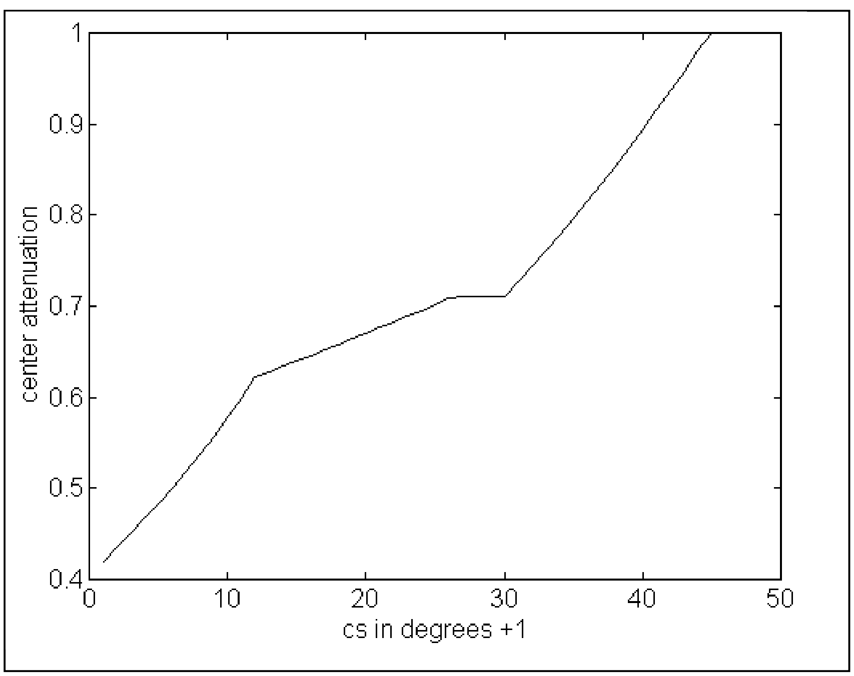

Figure 20: Center attenuation in the new decoder. Note the quick rise from .42, followed by a gentle rise, followed finally by a steep rise to the value 1 (the previous attenuation for full front steering.)

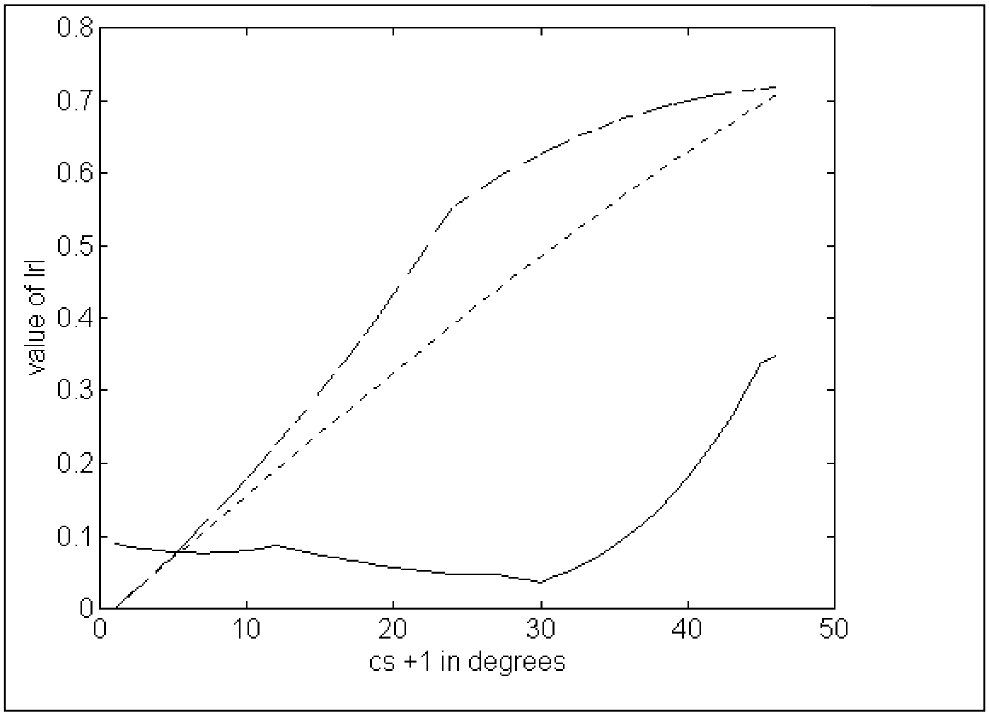

Figure 21: Solid curve - graph of GF needed for constant energy ratios with new center attenuation GC. Dashed curve is sin(cs)*corr1 (the previous LFR element). Dotted curve is sin(cs). Note that GF is close to zero until cs reaches 30 degrees, and then increases sharply. In a practical decoder we arbitrarily increase the value of GF after 30 degrees to end up at the value of 0.71 like the two other curves. This causes complete cancellation of the center channel from the left and right during strong steering. Also GF needs to smoothly interpolate to the previous value along the boundaries. In practice all these curves have a negative sign.

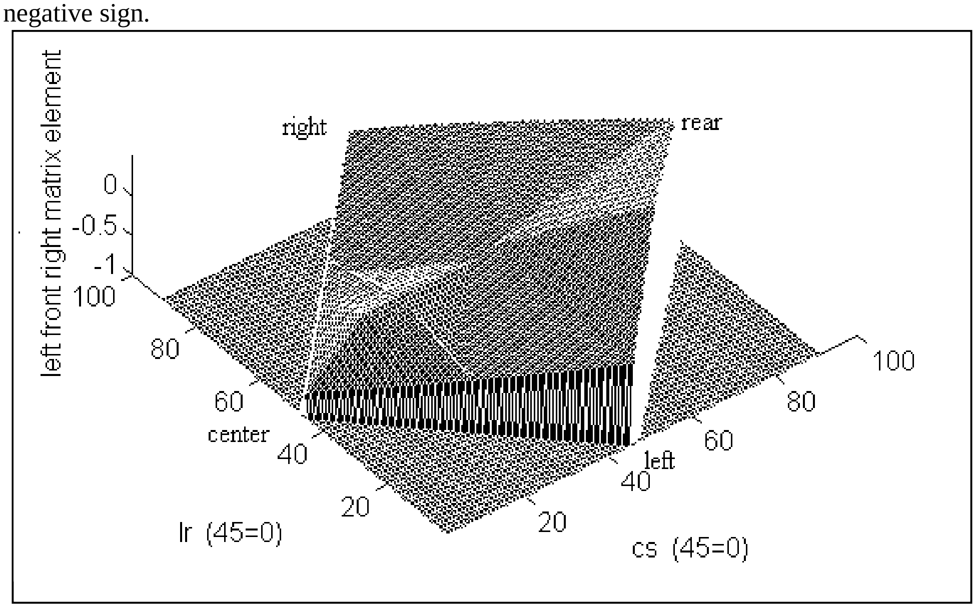

Figure 22: Left front right matrix element with the correction for center level along the lr=0 axis. Note that the value is zero in the middle of the plane (no steering) and remains zero as cs increases to ~30 degrees along the lr=0 axis. The value then falls off to match the previous value along the boundary from left to center and from right to center.

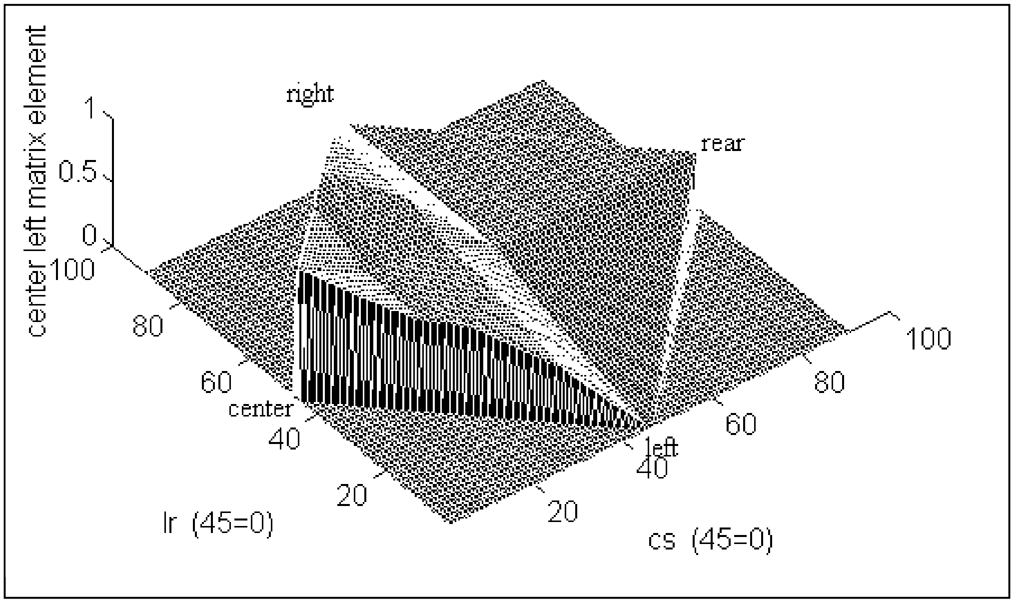

Figure 23: the center left matrix element with the new center boost function. Note the correction for panning along the boundary between left and center.

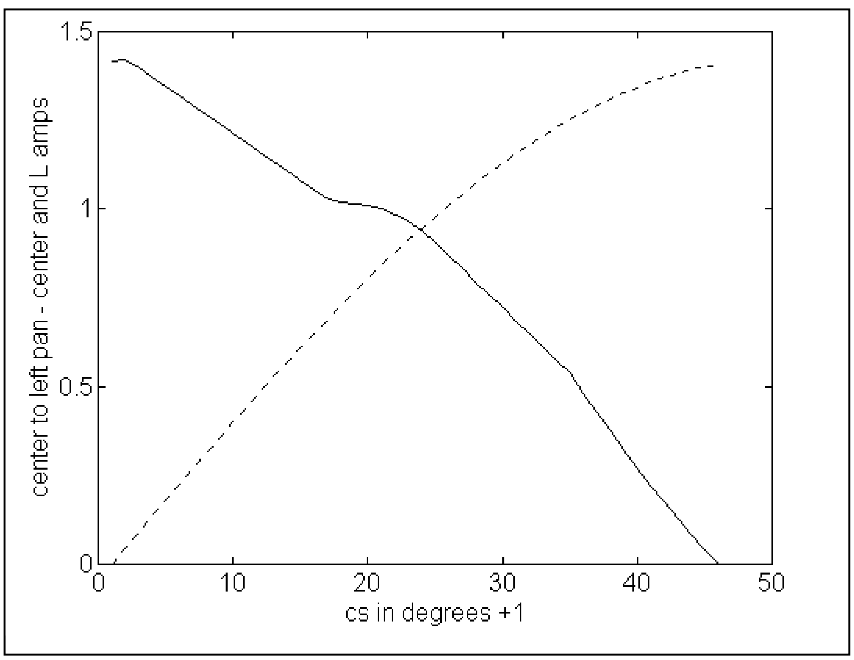

Figure 24: Solid curve – center output level as a steered signal pans from center to left. Dotted curve – Left output as a steered signal pans from center to left. (The values along the CS axis are inverted.) With the center correction the center pan function is reasonably close to a sin/cosine pan function.

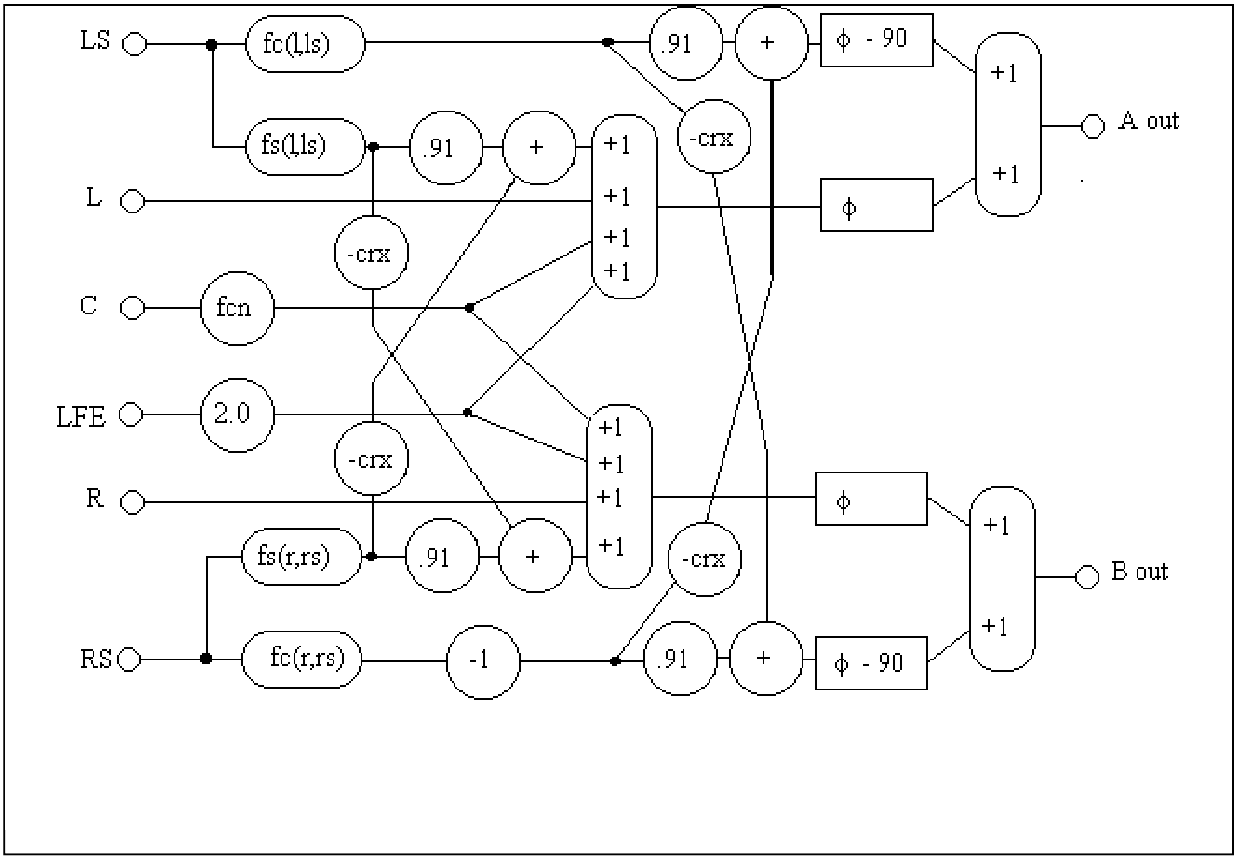

Figure 25. The new active encoder diagram