Pugh Method Example: Design of a Car Horn

This teaching example was originally developed by Professor Stuart Pugh. When it has been used in workshops with engineers, the same design always emerges as superior, even when very different groups conduct the evaluation. The following text describing this example is taken from *Creative Problem Solving: Thinking Skills for a Changing World*, College Custom Series, McGraw-Hill, 1993. We have made some changes from the original version by Professor Pugh, since we are using it as an illustration, not an evaluation exercise. Also, this example only includes the first round of evaluation.

Professor Pugh's example is used by several authors who teach the Pugh method in their design texts. We have rearranged and simplified the example to bring out some points we want to make more clearly. The datum is a widely used car horn (in the 1990's). Table 1 gives a list of design and performance criteria for the horn; these criteria are expressed not just as quantitative targets but as positive goals. They are stated in broad terms and ranges, not in restrictive detail. At this point, they have not been ranked according to importance.

Eight different conceptual designs were developed with this set of criteria. Two new designs were added to the matrix during the first round of evaluation. These concepts are shown in Table 2. Table 3 shows the completed Round 1 design evaluation matrix for the car horn. This matrix includes the additions to the list of criteria. Design #1 is the datum (the "best" existing product); it is entered in the first column next to the list of criteria. Each new design concept was then evaluated against the datum for each criterion.

TABLE 1: Design Criteria for Automobile Horn

Original List of Criteria

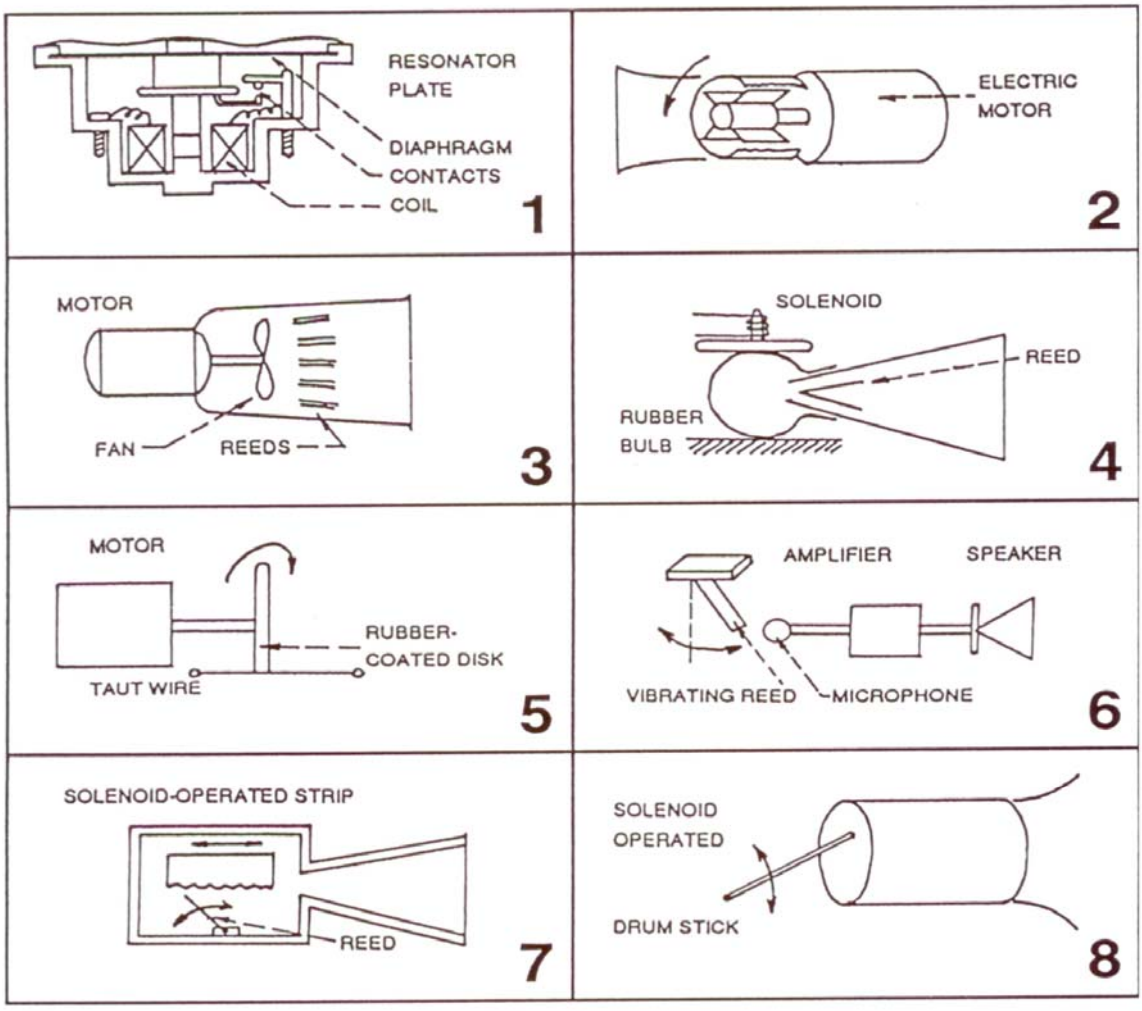
- Ease of achieving 100 – 125 decibel (sound level)
- Ease of achieving 2000 – 5000 Hertz (sound frequency)
- Resistance to corrosion (water, pollutants)
- Resistance to vibration, shock, acceleration/deceleration, wear-and-tear
- Resistance to temperature cycling and extremes
- Low power consumption
- Ease of maintenance
- Small size
- Long service life
- Low manufacturing cost
- Ease of installation
- Long shelf life

Criteria Added During the Round 1 Discussion

- Quick response time
- Small number of parts—simplicity of design
- Ease of operation (accessibility, emergency response)
- Ease of integration into the automobile subsystems
- Low weight

TABLE 2

Design Concepts for Car Horn (Pugh Method Example)



Creative Problem Solving, McGraw-Hill, 1993, p.354

Round 1 Evaluation Matrix for Car Horn (Example)

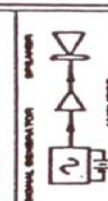
CRITERIA / CONCEPT										
	1	2	3	4	5	6	7	8	9	10
Ease of achieving 100-125 dbA	DATUM	—	—	+	—	+	—	—	+	+
Ease of achieving 2000-5000 Hz		S	S	S	—	+	S	—	+	+
Resistance to corrosion		—	—	—	—	S	—	+	S	S
Resistance to vibration		—	—	S	—	—	—	S	S	—
Resistance to temperature change		—	—	—	—	S	S	S	S	—
Simplicity of design		+	+	+	+	—	—	—	S	—
Low power consumption		—	—	—	—	+	—	—	+	+
Ease of maintenance		+	+	+	+	—	—	S	+	—
Small size		—	—	—	—	—	—	—	S	—
Long service life		—	—	S	—	—	—	—	+	—
Low manufacturing cost		S	+	+	—	—	—	S	—	—
Ease of installation		S	S	+	—	—	S	—	S	—
Long shelf life		S	S	—	S	S	S	S	S	—
Quick response time		—	—	—	—	—	—	S	+	—
Low weight		—	—	—	—	+	S	—	+	+
Small number of parts		S	S	S	—	—	—	+	+	S
Ease of operation		S	+	+	—	S	S	—	+	+
Ease of integration		S	S	+	—	—	S	S	S	S
TOTAL SCORE — POSITIVES		2+	4+	7+	2+	4+	0+	2+	9+	5+
TOTAL SCORE — NEGATIVES		9—	9—	7—	15—	10—	11—	9—	1—	10—

TABLE 3

Discussion of the Results of Round 1

When the Round 1 evaluation has been completed for each concept, we can take a general look at the results to judge the validity of the criteria. This is an important step that must not be skipped. In the example, we notice that not one of the new concepts was able to improve on the datum (or existing design) for resistance to vibration and resistance to temperature changes; none was able to achieve smaller size or longer shelf life. If one or more of these four criteria were important consumer requirements (with many complaints and warranty claims), the designers would have to do more creative thinking to come up with ideas that would address these concerns.

What happens during this first round of evaluation is much discussion about the criteria and what they really mean. A consensus may emerge about which criteria are the most important and should be given more weight than others. In the example, shelf life and size may be insignificant parameters—in this case, they could be eliminated from further consideration. On the other hand, quick response time, low weight, and small number of parts were found to be important and were therefore added to the list, as were ease of operation (especially during an emergency) and ease of integration of the horn into the car's systems (under the hood, in the steering column, and in the electrical system).

Can the students think of other important criteria (as customers)? For example, should the horn be operable when the ignition is off? Some years ago, we had someone back into our car while it was parked and we were sitting in it—there was not enough time to start the ignition, and without the engine running, the horn did not work. The result was a big dent and inconvenience for the repair and insurance claim.

Next, the total scores for each design are obtained. The positives and negatives are added separately since positives cannot cancel out negatives. The results from Round 1 show that some concepts were able to improve on the existing design; however, all concepts accumulated a large number of negative marks. Therefore, the next activity concentrates on making the concepts better by trying to eliminate as many of the negatives as possible. Concept #6 was expanded into two additional versions (#9 and #10), where Concept #9 has only one negative—high manufacturing cost. This may not matter if this horn is for a luxury car; if it is for an economy model, additional creative thinking may be able to reduce the cost. If low manufacturing cost is very important and cannot be reduced for this design, then other concepts that do not have this barrier need to be optimized further.

Although a team may decide to quickly throw out a few of the low-scoring concepts, this should be done with caution. Some of the better features or improved components of these concepts may be merged with other concepts for a better design. They should be examined for stepping stone ideas; thus they provide a valuable service. During this review and discussion of each design in an effort to make improvements, amended or new concepts are added to the evaluation matrix as new designs. This process may occur during the first meeting, or new concepts can be developed after an incubation period over several days. The later concepts would then be evaluated in Round 2.

This concludes the car horn example. A **Kitchen Lighting Example** in three rounds is given in the *Entrepreneurship* book by Lumsdaine & Binks and is available in PowerPoint upon request (see www.InnovationToday.biz for ordering information).