

Abstract

This report explains extensively a design of a multifunction pen in which several steps of design are followed to insure that the multi-function pen of good features and is suitable for mass production. This multi-function pen is expected to combine some of the writing tools to solve the common problem that most of the students face every day which is the loss of these important items and the difficulties of carrying them around. Three options of multi-function pen are introduced and explained thoroughly. Followed by that, the explanation of proper criteria of the multi-function pen and the scores that each option has out of these criteria. Then finally we have reached to the optimum solution which is option 2, as it has scored the highest points in its criteria.

1) Introduction

Design is a strategic plan in which humans' experience and knowledge are combined in order to achieve desired goal under specified standards and constraints such as budget, personnel, legality, material properties and availability, competition and manufacturability. Design has certain standards that can be accomplished when applying several steps which are called "steps of design". Engineers use these design steps in almost everything they do or construct, to minimize the errors and to reach the highest expectations of any objectives. This means that following the design steps is very essential to produce ideas that are successful and suitable for mass production. Therefore, we as students of engineering must apply these steps to reach the objective of our product which is multi-function pen. We have determined the objective of our design after searching for different types of multi-function pen. These different types of multi-function pen are listed in section2.

Step 3 (Identify constrains and criteria of success)

In order to have successful design that is suitable for mass production we have to know the constraints and the criteria of success. Our design is targeting the individuals in education field mainly students and office workers such as secretaries. Therefore the design must have certain properties that identify its facilities or its complexity. These properties are reliability, serviceable, compact design, convenience, the safety, low price, (aesthetics) nice outer shape, practicality, light weight and eco-friendly. As shown and explained in table 1. The constraints for the multi-function pen have been defined as: the budget, personnel, legality, availability of materials and manufacturability of the design.

Table 1 Properties of multi-function pen

property	Weight	Justification
Reliability	9	The improvement of the writing tools is intended for (individuals in education field). So the reliability is essential.
Compact design	8	Although the compact design is desirable, it is not highly critical or crucial.
Environmentally friendly	8	The design must be eco-friendly, Doesn't have negative effect on the surrounding environments. Also includes the recyclability of the materials within the design.
Convenience	10	The marketing expert indicated that no matter how good the design is, if it is inconvenient to use It will not be sold. So convenience is important.
Low price	9	This product is designed for individuals in education field especially students so the price should be low
(Shape)Aesthetics	8	People will not buy something ugly so the aesthetic is important for this design
Light Weight	8	The light weight is very crucial .The design is moveable product, so in order to reduce effort of carrying it around should be light not heavy.
Durability	8	(How long this product lasts?)Students obviously wants product that perform satisfactory over a long period of time.
Serviceability	9	The product which is maintained easily is serviceable. In other words, when repairing any product that is composed of many parts, its' spare parts must be available in the market and the availability of these part decide whether this product is serviceable or not.
Safety	10	The multifunction pen is designed to benefit people not to harm them, so the product is designed with safety in mind.
1=Poor, 10=Excellent		

Step 5 (Feasibility study) Analyze each potential solution

An evaluation matrix is used to help selecting the best option as shown in table 2. The best option is the option that scores the highest points in the 10 properties of the multi-function pen. Which are the following:

- **Reliability:** Option 1 and 2 are reliable because each one of these options will function properly whenever they were needed therefore they scored the same points. In contrast option 3 will not be reliable at all the time, as it's used only in indoor places because the climate factors such as humidity and sunny weather could affect badly on the multifunction's ink. In other words humidity and sun removes ink that option3 is consist of and if any writing used by this ink is exposed to these factors they will vanish rapidly. That's why option 3 scored lower points than option 1 and 2.
- **Compact design:** Compact property depends on how large or small the design is. In other words, it depends upon the size of the design. Option 1 and 2 are closely similar in sizes, but option 1 has an extra piece which is the key hanger. So option 1 is slightly larger than option 2. Therefore option 1 scored less that option 2. Option 3 has neither key hanger nor paper hanger so it's smaller than both options 1, 2. Thereby it is the most compact and it has scored the highest points.
- **Environmentally friendly:** All of the three options are environmentally friendly as the ink doesn't emit any harmful substance and it's decomposable. While the plastic and metal materials within the pen are not decomposable but recyclable. However the recyclable levels of the materials differs , all kinds of metals are recyclable, but for plastics; the strongest and breakable plastics can be recycled easily while the soft and flexible plastics are recycled with higher level (difficult to be recycled) [7]. Biased on this information, option 3 has scored the highest because it has only 3 inks within the pen, means only 3 flexible plastic inks and has no hangers which makes it easier to be recycled. Option 1 has more parts, therefore more effort is required for recycling. While option 2 is slightly more recyclable than option 1 as it doesn't has a key hanger. But, the soft and flexible stick notes within the cover of the three options are hard to be recycled therefore the three options scored low points.

- **Convenience:** Option 1 has key hanger and should score the highest points but it consists from separate parts which make it in stable state. Option 2 has combined all components together in one part therefore it has scored the highest points. While option 3 has scored the lowest points because it doesn't have neither key hanger nor paper hanger.
- **Lower Price:** Option 1 has higher price as it consists from more parts and it has a key hanger that makes the price more higher. Option 2 is neutral as it has scored more than option 1 and less than option 2 because it has hanger and corrector within the pen, while option 3 doesn't have hangers nor corrector, therefore it has scored the highest points.
- **Shape/Aesthetics:** Option 3 has scored the least number of points it doesn't have hangers in its outer shape which made it unlikable, and for option 1 its shape is good and scored high points but option 2 scored higher as it has colored curly rubber under the highlighter which gave it an attractive shape.

- **Light weight:** Option 1 has more pieces (external pieces: corrector and highlighter). Therefore it's heavier than the other options. Option 2 is slightly lighter than option 2 as it consists of light inner corrector, so it has scored more than option 1. While option 3 has no corrector at all, it uses small rubber that is attached in the top of the cover which erases the pilot by friction, however the pilot ink is heavier than the ordinary ink that is why option 3 has only 3 colors to make it equal in size with the inks of the other options. Therefore option 3 scored the highest points then comes after option 2 then 1.
- **Durability:** All of the options are expected to function properly over a long period of time. As they are constructed with hard plastic that is not easy to break. It's a common sense that once the ink/ corrector/stick notes ran out from these options they would be considered as expired product (out of use), and that is why we have made most of the options part's replaceable. Option 1 has the feature of replaceable parts which are the inks, corrector, highlighter and stick notes and thereby it has scored the highest points. Slightly same words for option 2 but the highlighter is stable and cannot be replaced, so it has scored lower than option 1. For option 3 it has only refillable stick notes therefore it has scored the lowest points.

- **Serviceability:** As explained before in the table 1, the availability of the spare parts of the product decides whether the product is serviceable or not. All of the three options got the same score which is 9 out of 9, because it is estimated that the spare tools of the three options (ink containers, sticky notes, highlighter & corrector) are available in every book store.
- **Safety:** All of the three options scored the same points as all of the three are designed with safety in mind. All the edges of the multi-function pen are not sharp and safe. Also the inks within the three options are not toxic but it is harmful when swallowed that's why these pens are designed only for educated people not for kids.

Table 2 Evaluation matrix for multi-function pen

property	Weight	Option 1		Option 2		Option 3	
	W	S	SxW	S	SxW	S	SxW
Reliability	9	9	81	9	81	6	54
Compact design	8	7	56	6	48	8	64
Environmentally friendly	8	3	24	4	32	5	40
Convenience	10	8	80	10	100	6	60
Low price	9	5	45	6	54	7	63
(Shape)Aesthetics	8	6	48	8	64	5	40
light Weight	8	7	56	6	48	8	64
Durability	8	7	56	8	64	6	48
Serviceability	9	9	81	9	81	9	81
Safety	10	10	100	10	100	10	100
TOTAL			627		672		614
1=poor,10=Excellent							

6) Conclusion

After reaching the optimum solution which is option 2 by following the design steps from 1-6, this report is going to be presented to higher management and constructing option 2 is to be projected. Option 2 is expected to be suitable for high production and estimated to be very profitable product; this is because of three main reasons. First reason is because it's reliable with very good properties. The second reason is that people like to discover and buy new things. The third reason is that people like devices and tools of multi-function properties. For example, people like to have camera, internet and cell phones combined all in one. In other words people always seek for new ways that makes their life easier and saves their efforts.