Engineering Workshop generate waste: A plan for its management

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Abstract: Engineering workshops are an integral part of every technical Institute. All engineering graduates of all streams are supposed to go through engineering workshops in their first year of study. The workshops required to focus on the issues pertaining the management of wastes generated while the students are learning (working) and to develop consensus that waste management is a problem. Workshop waste material is a key factor when assessing the sustainability of a manufacturing process. The cost of the raw material assigned to the institutional workshops is very high because of its high utilization by all the engineering graduates, so it is very important to manage the raw material as well as the finished product of every shop to convert into useful household product. This paper attempts to suggest the finished product of one shop to be utilized as a raw material for another shop in order to reduce the running cost of engineering workshops and the objective of this paper is to promote the awareness to the engineering graduates towards the reuse of the used material of the generated mechanical wastes in the institutions.

Key Words: Workshop, Machine shop, Carpentry Shop, Re-used material, finished product and cost.

1. Introduction
Waste management is the need of current era. Focusing on waste can help you to address high raw material prices, rising costs of hazardous waste treatment and disposal. It will also help towards the sustainability of operations in various shops of the workshops. Proper planning of waste management provides a range of practical and cost-effective options.

There are current advantages of waste management are as follows:
1. Reduce the incurred input and waste disposal costs.
2. Helps in reducing the environmental problems.
3. In will be competitive in terms of budget for other institutions not following the norms of waste management.
4. Reducing the cost of purchasing metals.
Other institutes not following the planning of waste management might understand the importance of R3 i.e., reduce, recycle and reduce in order to utilize the materials in a cost-effective way and environmental safety.

Before implementing waste management in any area/section of industry/institute followings points should be considered.

a. Training of the staff and awareness among the students and employees.

b. Support from the management.

c. Discuss benefits of waste management among every employee.

2. Product and process innovation

To implement the concept of reusing the waste materials of workshops of any institute or industry the proper planning and sufficient knowledge of reusing such wastes into useful forms is the key factor and plays a significant role in this regard.

This will help in the sustainability of process thus ensuring reusability of the finished product / wastes of the various sub sections in the workshops like carpentry, machine shop etc. and to convert from one form to other without using fresh raw material. Some of its kind of innovative ideas for utilizing such wastes have been discussed in the subsequent sections of this paper.

Many researchers [1, 2] have discussed importance of the waste management for environmental benefits. Some of them also suggested the utilization of waste within the same manufacturing unit to reduce transportation thus minimizing transportation costs and save time. Waste management also helps in making the society sustainable [3]. Proper planning and right approach play a vital role to achieve this goal.

Each production unit must be aware of the flow of the raw materials to each of the department / units and there must be some sort of arrangement for the monitoring of the consumption of raw materials. It helps in the proper management and will further enhance the concept of reusability of waste material [4]. Every individual should help in achieving zero waste or waste prevention then only one can think of clean society [5]. By applying / incorporating proper waste management techniques the efficiency also increases [6]. Nowadays pollution is the global problem. Waste management at micro as well as at macro level is the only possible solution of pollution control and conservation of raw materials [7]. It will also ensure the availability of these precious raw materials for future generations [8]. Initial mechanical properties and process parameters plays a significant role in determining the properties of the developed composite material [9, 10]. Process adopted for the manufacturing of goods is an important factor as it is responsible for the mechanical properties of the finally developed good [11, 12]. The applied heat treatment process have a reasonable impact on microstructure and mechanical behaviour of the material [13].

3. Methodology

3.1 Waste management of machine shop

Some of the important techniques of waste management that are being practiced in the host institution are discussed as follows:

In institutional machine shop of engineering workshop fresh raw materials (Mild Steel 25mm round bar) is used by first year engineering graduates as a part of their course curriculum for performing some operation like facing, turning, step turning, taper turning, knurling, and grooving etc using center lathe machine tool. The product obtained is considered as a waste material of machine shop. This waste
material, 25mm diameter mild steel rod is further utilized for practicing in making the V-thread on lathe in manufacturing Science-II lab.

Also, the waste material is reused in forging shop for converting the shape from round into square through induction heater. The product is obtained from forging shop is re-used again in machine shop/forging shop for finishing the surface by means of surface grinder for the making square chisel and square punch by means of induction furnace.

The reusability of the finished product of material l25mm round bar is shown by Fig. 1 and Fig. 2.

Fig.1 Re-used waste Material flow of Machine shop
3.2 Waste management of Fitting shop
In Fitting shop fresh raw material (50x6mm) of mild steel is used for practicing by first year engineering graduates, operations like sawing, filling, drilling, taping, etc in engineering workshop practice lab using manual tools. The product obtained is called considered waste material of this shop. This waste material is re-used in Fitting shop for making washer and/or square nut. These washers and square nuts are very useful product as far as their practical applications are concerns. Fig.3 shows the flow chart of fitting shop.

![Flow chart of fitting shop](image)

Fig.3 shows the material flow chart (Mild Steel Flat)

3.3 Waste management of welding shop
In welding shop fresh material (50x6) mm of mild steel is used for practice arc welding and making single butt joint in engineering workshop practice lab of first year engineering graduates. The single butt joints a waste material. The welded part is removing through sawing process and separated. This waste material is re-used in Fitting shop for making lap joint through arc welding. Fig.4 shows the flow chart of welding shop.

![Flow chart of welding shop](image)

Fig.4 Material flow chart (Mild Steel Flat)
3.4 Waste management of Sheet Metal shop
In sheet Metal shop, fresh material G.I. sheet of 29 gauges is used for making Square box or Rectangular Tray in engineering workshop practice lab of first year engineering graduates. The box or tray is dismantled and considered as a waste material. This waste material is further utilized for making G.I. Sheet washer. This G.I. Sheet washer is a very useful product. Fig. 5 shows the material flow chart of G.I. Sheet.

![Material flow chart of G.I. Sheet of 29 gauge](image)

Fig. 5 Material flow chart (G.I. Sheet of 29 gauge) of Sheet Metal Shop
3.5 Waste management of carpentry shop

This is the process of shaping timber, using hand tools, the produced products are used in building construction, such as doors and windows, furniture manufacturing, patterns for molding in foundries, etc. Carpentry work mainly involves the joining of wooden pieces together and finishing the surfaces after shaping them. The term joining is also used commonly for structural applications. Fig. 6 shows the material flow chart of carpentry shop.

Fig.6 Material flow chart of Carpentry Shop
4. Result and Discussions
By re-utilizing some material of various shop, the expenses of central workshop is reduced and shown in Table 1. The reduction in cost can easily be seen by Fig. 8. By re-utilizing the final cost is reduced by about 66.78% shown graphically.

This is the main advantage of reutilization of the finished product of one shop as raw material for the other shop. This practice is very useful for the sustainability of the central workshop.

Table 1: Raw material requirement

| S. No. | Raw Material         | Raw Material Requirement before Re-use | Raw Material Requirement after Re-used |
|--------|----------------------|----------------------------------------|---------------------------------------|
|        |                      | Consumption (kgs)                      | Cost (Rs.)                             |
| 1      | MS Square 25mm       | 30 kg                                  | 1500                                   |
| 2      | MS Square 20mm       | 118 kg                                 | 5900                                   |
| 3      | MS Flat (50x6)mm     | 196 kg                                 | 9800                                   |
| 4      | MS Round 25mm        | 300 kg                                 | 15000                                  |
| 5      | G.I.Sheet 29 SWG     | 07 No.                                 | 3850                                   |
| 6      | Soft Wood            | 0.175 m$^3$                            | 3786                                   |
|        | **TOTAL (Rs.)**      | **39836**                              | **13231**                             |

Figure 8: Comparison of cost before and after re-use of materials.
5. Conclusion
The proposed method of reutilization of the finished product of one shop for other shop as raw material is strengthened the concept of 3R i.e, reduce, reuse and rework for sustainability of any production organization. The results indicate that by increasing the reusability of the finish product of one shop as raw material in other shop, the expenditure of workshop is reduced 66.78%. This method is help to reduce waste as well as wealth of the organization and environmental protection.

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