

# A hierarchical system for purchase management in a student-run makerspace

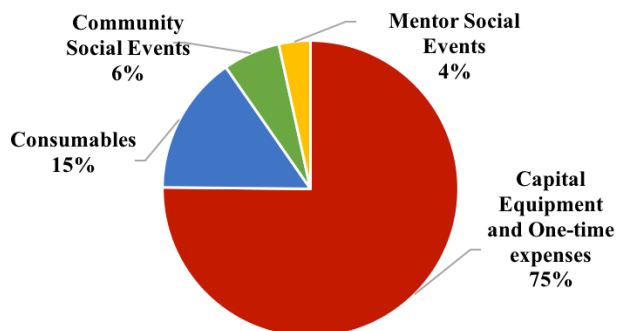
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## INTRODUCTION

To appropriately manage purchases in a makerspace run by 40+ student volunteers who have supervisory and management roles as “Mentors” to the community, it is important to have a well-defined purchasing system. There are several requirements for this purchasing system. We need an easy place for Mentors to request purchases. Additionally, we have a detailed policy that defines levels of purchase and the policy for each, preventing unnecessary discussion on small items, but encouraging participation from all Mentors and Users for new capital purchases. Finally, a system to track purchases allows us to monitor our finances across several accounts, and sort purchases by the several executive committee members who are qualified to make purchases for MIT MakerWorkshop\*.

## CATEGORIES OF PURCHASES

There are several needs for purchasing in MIT MakerWorkshop that group into four categories: capital equipment and one-time purchases, consumables (which include new tools to replace tools that are used up and stock that is available for purchase by Users, such as 3D printer plastic and acrylic for the laser cutter), items for mentor socials, and community socials including food.



*Fig. 1 The breakdown of the Y1 spending of the MIT MakerWorkshop. Note that Y1 refers to dates between July 2015 and July 2016. The bulk of the expenses were Capital Equipment and One-time expenses which include new items such as additional machine tooling. We anticipate spending in this category to decrease this year while we expect spending on Consumables to remain constant.*

The method used to purchase and track our account for each is described below.

\* Formerly named MIT MakerWorks

*Fig. 2a The purchase request form (form 1) is used by any mentor to request a purchase. A member of the executive committee will check this form and make purchases typically twice a week.*

*Fig. 2b The account tracking system form (form 2) is used when a purchase is made by a member of the executive committee. Google sheets formulas automatically sort and display purchases by both purchaser, and by account.*

1. Purchase request is entered into purchase request form (Fig. 2a).
2. Executive committee member (usually Treasurer) purchases item, and enters a record into account tracking system (Fig. 2b).
3. The account tracker spreadsheet (Fig. 2b) aggregates purchases based on account, and based on individual who makes the purchase.
4. The aggregated spreadsheet includes a section organized based on purchaser and is used for accounting and processing of MIT credit card charges.

5. The aggregated spreadsheet also includes a section organized based on account and is used to track the state of each account (as we only get monthly updates, and these do not account for charges that have been made, but not assigned to a specific account yet).

### MACHINE TEAMS

In MIT MakerWorkshop, each machine or group of equipment is managed by a machine team that is headed by a machine master. The mill, lathe, laser cutters, 3D printers, CNC router, benchtop tools (drill press, band saw, sanders), electronics area, hand tools and hardware, and electronics and measurement tools all have a team that gives training on the machine and manages repair, maintenance and tooling stock. By assigning specific individuals, we can ensure that material does not run out without being noticed, and action is taken to maintain operation of the machines.

The machine teams make purchases for their machine by submitting a purchase request through a Google form. The Treasurer makes the purchases in groups twice a week and allocates the charge to the proper account. This hierarchy of machine management and purchase structure ensures purchases occur quickly, but prevents the same item from being ordered twice by mistake.

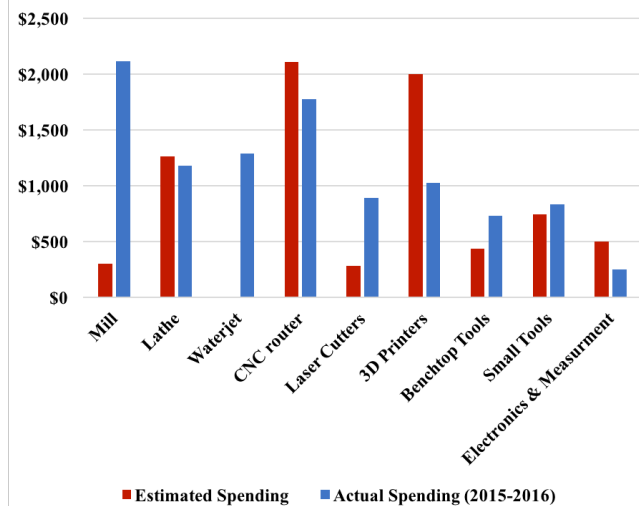


Fig. 3 This figure shows our projected vs actual usage rate for resources associated with each machine. Some estimates are high, as we built in the ability to buy new types of tooling into certain machines, to account for both tool damage, and expansion of our available resources. Since we started charging at cost for 3D printing, the usage rate dropped below what we predicted. We have also had success with not losing or breaking hand tools, as we have not needed to replace anything in the first 1.5 years.

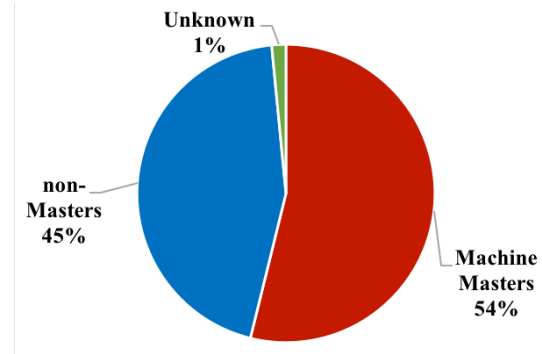


Fig. 4 This figure describes the purchase requests made by Machine Masters, non-Masters, and Mentors whose position is unknown. We see a nearly equal split between purchase requests from Machine Masters vs non-Masters. This shows that all Mentors are encouraged to help keep the shop running smoothly, which decreases the burden on the Machine Masters.

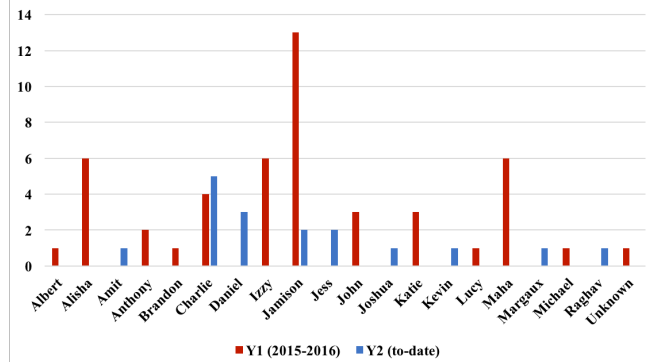


Fig. 5 This figure shows the number of purchase requests each year by different Mentors. Note that Y1 refers to dates between July 2015 and July 2016. Y2 (to-date) refers to dates between August and October 2016. The high number of requests in the first year by Jamison was for parts related to keeping the 3D printers running.

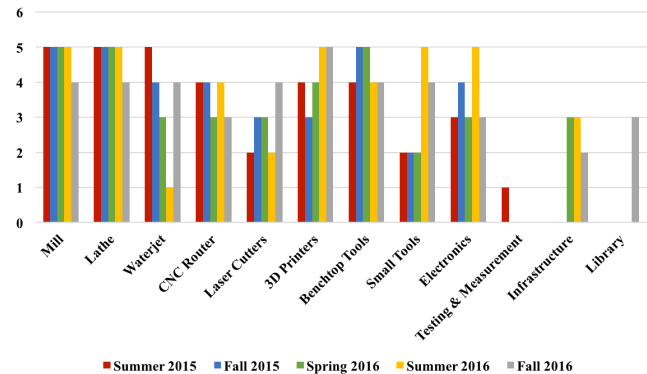


Fig. 6 Shown in this figure are the machine team sizes. Over the past 1.5 years, we have adjusted machine team sizes to keep up with need. For example, laser cutter team grew recently as we are in the process of adjusting our ventilation system. New initiatives have been started, including an infrastructure team, and a library tool check out initiative we are piloting for all of campus.

## STOCK TO PURCHASE

Several things are paid for by use, including 3D printer filament, acrylic for use in the laser cutter, and garnet for the waterjet. When a User wants to use any of these machines and purchase these items, they can be charged by the MIT Mobius mobile application. This money goes to a discretionary account. When purchase of one of these items is made, the charge is applied to this account. This allows us to track the account over time, with the expectation that after our initial materials purchase, the funds in this account should not increase or decrease over time.

## CAPITAL EQUIPMENT

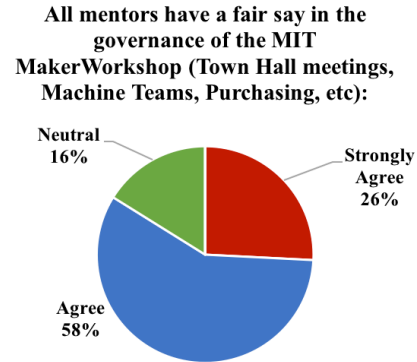
There are three levels of purchase in MIT MakerWorkshop: less than \$250, \$250-\$3000, and more than \$3000. For items less than \$250, the treasurer can make the purchase. Items between \$250 and \$3000 need the approval of the executive committee.

For capital purchases (items about \$3000), all Mentors and Users are encouraged to give feedback about what tools and equipment they use in the shop the most, and what items they feel would be the most beneficial. Individuals are allowed to suggest any piece of equipment. We compile a list and send it out again to get specific feedback and rank on a variety of factors, which helps us to determine what would work well in MIT MakerWorkshop. Once a decision has been made, the executive committee must approve the purchase. From there, the entire mentor community must approve the purchase by a simple-majority vote. After being approved by the Mentors, the purchase is brought to the faculty advisor for the space (Maker Czar) who serves as our representative within the department, who must also approve the purchase. Once the purchase is approved, we can follow out the necessary steps to complete the purchase.

Purchase Level	Approval Process
<\$250	<ol style="list-style-type: none"> <li>1. Purchase made by Treasurer at their discretion</li> </ol>
\$250-3000	<ol style="list-style-type: none"> <li>1. Purchase approved by executive committee by a simple majority vote</li> <li>2. Purchase made by Treasurer</li> </ol>
>\$3000	<ol style="list-style-type: none"> <li>1. Mentors and Users give specific feedback on suggested purchase</li> <li>2. Purchase approved by executive committee by a simple majority vote</li> <li>3. Purchase approved by the faculty advisor (Maker Czar)</li> <li>4. Purchase made by Treasurer</li> </ol>

*Fig. 7 This figure details the levels of purchasing at MIT MakerWorkshop. The levels are delineated by dollar amount of spending, and require different levels of approval accordingly.*

There are several reasons for this method. First, it establishes a system of checks and balances, where an ambitious treasurer cannot single handedly make large purchase decisions. Second, it allows Mentors and Users to have buy-in to the equipment we purchase. Finally, it gives the department a chance to give us input in what equipment will be beneficial to have in the space.



*Fig. 8 Shown in this figure are the results from a survey sent to all the Mentors of the MIT MakerWorkshop in Fall 2016. Of the 31 respondents, the vast majority of them felt that they had a fair say in the governance of the space, including purchasing of equipment for the space. Note that no respondents chose "Disagree" or "Strongly Disagree" to this question.*

## CONCLUSION

The MIT MakerWorkshop is a unique makerspace on the MIT campus as it is run by 40+ student volunteers who have supervisory and management roles as "Mentors" to the community. To appropriately manage purchases for this space, it is important to have a well-defined and trackable purchasing system. We have made it easy for Mentors to request purchases, while also having a detailed policy to describing purchasing which prevents unnecessary discussion on small items, but encouraging participation from all Mentors for new capital purchases. Finally, we have system to track purchases allows us to monitor our finances across several accounts, and sort purchases by the several executive committee members who are qualified to make purchases for MIT MakerWorkshop.

Moving forward, a useful feature to add for the purchase tracker is a category section, where a selection can be made between capital equipment, one-time expense, consumable item, etc. This additional feature would allow for easier analysis of the purchases made for MIT MakerWorkshop.

## ACKNOWLEDGEMENTS

The authors would like to thank MIT's Provost Martin Schmidt, the MIT School of Engineering, the Martin Trust Center, the Richard H. Lufkin Memorial Fund, the MIT Department of Mechanical Engineering, Prof. Dennis Freeman

and the MIT Project Manus initiative for providing support, encouragement and funding for the MIT MakerWorkshop. The authors would also like to thank Prof. Martin Culpepper for serving as an amazing faculty advisor (Maker Czar) for our space. Finally, the authors would like to thank all Mentors, past and present, for all their time and dedication into designing, building, and maintaining the MIT MakerWorkshop.