A White Paper for the Proposed SoE Maker Space at the Request of Dean Garde, SoE
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This document is a white paper relative to the proposed School of Engineering (SoE) – Maker Space (final name to be determined by Dean Garde). The information in this document was compiled based on the concept that the facility will be managed by a new Rensselaer Union sanctioned student club with a focus on engineering design, innovation, and collaboration. The club will own and manage the space with oversight from an advisory council consisting of SoE faculty, technical staff, and student club officers. The authors of this paper recommend organizing a pilot group of students (6-8) to refine the recommendations outlined in this document and beta test the facility during the Fall 2015 semester.

The contents of this document will be presented to the pilot student group as a reference point for further development and refinement by the students. An ASEE Journal Paper by Forest, C., Moore, M., Jariwala, A., Fasse, B., Linset, J., Newstetter, W., Ngo, P., & Quintero C., (2014), The Invention Studio: A University Maker Space and Culture, ASEE Journal of Advanced in Engineering Education, pg. 1-31, retrieved from http://advances.asee.org/wp-content/uploads/vol04/issue02/papers/AEE-14-1-Forest.pdf was used as a reference for this white paper.

Work done during the design and development of this facility would be documented and published in ASEE Journal, Innovation Journals or other appropriate journals to share lessons learned with other institutions.

The following topics are for students to consider and debate when organizing and managing this space; definition of this maker community, measures of success, objective of the space, club organization, safety, training, day-to-day operations, technical staff support, and budget structure. The founding student group must also consider the broader impact of the facility as a platform of educational innovation excellence and the future direction of the space.

- **Maker Space Objective** - The objective of this space is to provide an environment to support innovation, collaboration, and proof of concept modeling tools to enhance the educational process for students.
- **Club Organization** – Form a Rensselaer Student Union Club considering the objective recommendations. Define an organizational structure considering the need for specific leadership roles including a facility director, access manager, safety manager, financial manager, equipment manager, as well as expert machine user structure. A marketing plan for the space will need to be developed as well. A suggested requirement for the constitution of the leadership team is that the club structure includes representation from a broad spectrum of potential users including underrepresented student groups, student clubs, different engineering disciplines, and other campus schools expressing an interest in partaking in the management of the facility.
- **Safety** – The organizing group for this space must maintain safety at all times for users and equipment while fostering an environment of design freedom, innovation, and creativity. It is recommended that the group adopt the present SoE Safety Policies as the foundation of a safety

program and then build on the policies and create specific guidelines for resources in the space as needed.

- **Training -** From a training perspective the group should consider an expert users system. Within this system expert users can train others interested in operating equipment in the space. The training system could include a three level system (red, yellow, green) indicating the level of assistance / training needed to operate equipment. For instance, red indicates only expert users can operate, yellow indicates assistance needed by expert users, and green indicates little or no training needed to operate equipment. Some type of validation system needs to be in place to indicate the skill level of any user coming to the space.
- **Day-to-Day Operation** – The organizing group must consider resource scheduling, room access, equipment user logs, class and project priorities, and the number of potential users (student clubs, How to Change the World Challenges, IED, MANE Innovation Classes, Manufacturing Innovation Learning Lab classes, etc.) when developing a plan for day-to-day operations.
- **Technical Staff Support** - The organizing group for this space should assume to operate and maintain the area with approximately 10% staff technical support per week (based on a 40-hour work week). This space should be self-sufficient and only require technical staff assistance for limited machine repairs, machine operation questions, data manipulation questions, and other high-level technical challenges. Requests for assistance should be directed to the SOE Manager of Fabrication and Prototyping to balance the workload for staff.
- **Budget –** Students need to consider funding sources for; replenishment of supplies, software and hardware maintenance agreements, equipment purchase / upgrades, and funding for club type projects for student competitions. One cost model at Georgia Tech (GT) starts with an assumption of 1,000 uses per month with a $40 per student rate per semester as a figure related to operating their Maker Space. GT also considers a $40 per student rate for equipment purchase and depreciation figure as well. Given these figures the space at GT has an operational budget of $100K for operation and $100K equipment budget per semester. Obviously, the proposed SOE space will not operate at this level at start-up but the GT models should be considered when developing a budget for the space. Some examples of budget support include; at the University of Michigan students supply their own materials for the 3D Printers, at GT individual classes and departments contribute a semester fee to support student projects, and 5% of funding comes from direct donations, industrial support, alumni, and student government funding.
- **Community Building - Broader Impact** - The student team needs to define the definition of a Maker Community at RPI and consider the impact of this facility on the student life experience at RPI, the importance of the facility as a showcase for funding agencies such as Venturewell, NSF Launch pad, NIH, and prospective students, as well as the potential to use the resource for collaboration with other universities such as MIT Innovation Labs, Stanford's Innovation Labs, etc. The facility can also become the link to other campus prototyping resources for further development of an idea including the JEC Student Machine Shop, School of Architecture Wood Shop, and the Manufacturing Innovation Learning Lab (MILL).
- **Community Outreach –** On an annual basis the facility will:
    - Conduct local high school programs for students promoting STEM education
    - Promote STEM education to prospective underrepresented student groups pursuing an education in STEM related careers

- Conduct symposium for undergraduate students on "Innovation and Manufacturing specially Additive Manufacturing" open to all students
- Conduct all of these community outreach activities in collaboration with the SoE Industry Affiliate Program Initiative

- **Future Direction -** The students should consider the following questions when thinking about the longevity of the space :
  - What will this space look like in 5 years?
  - How will new technologies relative to a virtual environment impact how future students collaborate, innovate, and prototype?
  - What horizon prototyping methods will impact the space?
  - How do you measure the impact of the space on innovation and creativity?
  - How does the advisory council impact the strategic planning?

ADDENDUMS TO PUBLICATION

v.2 - 9/8/16 - The following topic should also be considered as part of the organizational plan along with the topics listed in this white paper.

- **Impact** – The students should consider how to measure the impact of the community and Maker Space.
  - Examples
    - X or Controllable Parameters: 1) # of students, and their departments or clubs, using the room, 2) range and average number of hours spent per visit, 3) utilization rate of equipment - 3D printing, sharp led, smart kapp etc. 4) # of disclosures submitted to OTC, & # of provisional patent submission to USPTO, 5) # of External Collaborators engaged in projects - industry partners, research labs, investors etc.
    - Y or Outcomes or uncontrollable parameters: 1) # of patents granted by USPTO, 2) # of innovation challenges won - NSF I Corps, VentureWell E-Teams, NY State challenges etc. 3) # of External Collaborators engaged in projects hiring students using the space, 4) # of startups formed by students using the space, 5) # of licensing agreements with RPI/Investors/Industry etc. based on patents originating from Innovation crucible/makerspace.
    - X number of students use the facility, Y student groups/professional societies participate/help man the space during certain times, national prizes for design/manufacturing as a result of enabling activities conducted in the space, etc.
    - Number of outreach events / attendance (example Maker Challenge)