Q1. GEMS102 Project Sheet Spring 2018
The first part of your project is due by 12:00pm (NOON) ET on February 26, 2018.

Guidelines:
- You are encouraged to talk with your Section Leader and Gemstone staff regarding your project sheet to get feedback in advance of your submission.
- A committee of Gemstone staff and GEMS102 Section Leaders will review all project sheets. Authors will be notified by 3/01 whether their project sheets are accepted on the first try; otherwise, they will be asked to revise and resubmit.
- Each project sheet may have no more than four authors and once a project sheet has been submitted (by 2/26/18 at noon), NO new authors may be added to the sheet.

Q2. Author 1 Full Name*

Lauren Cho

Q3. Author 1 Email Address*

lcho418@terpmail.umd.edu

Q4. Author 2 Full Name

Varun Iyer

Q5. Author 2 Email Address

varun.iyer2017@gmail.com

Q6. Author 3 Full Name

Sean Winters

Q7. Author 3 Email Address

seanwintershhs@gmail.com

Q8. Author 4 Full Name

Q9. Author 4 Email Address

Q10. Research project title: *

TEAM CONTACT (Creating Optical Necessities Through Affordable Curing Techniques): 3D printing optical lenses using an affordable ultraviolet DLP (Digital Light Processing) printing process

Q11. Describe the overarching research problem.
Is this a problem for anyone other than those affiliated with UMD? How does this fit into a larger societal context or problem? How does this issue represent larger problems?
Has this problem been documented by other scholars? How will it build on work conducted by other scholars?
How is this project innovative? *

This project is innovative because as of right now, there is only one company that claims to provide feasible 3D printed optical lenses, and UV DLP Printing is an emerging technology in 3D printing that boasts fast, accurate printing. According to the World Health Organization (WHO), “An estimated 253 million people live with vision impairment: 36 million are blind and 217 million have moderate to severe vision impairment” (Vision impairment and blindness). More broadly speaking, it is estimated that over 2 billion people on Earth need glasses for proper vision but don't have access to them (Wray, 2016).This number would be significant because according to Worldometers, there are currently approximately 7.6 billion people in the world (Current World Population), and this would mean 3.3 % of the world population is impacted by vision impairment. Also, according to WHO, “Over 80% of all vision impairment can be prevented or cured” (Vision impairment and blindness). Hence, with greater affordability and accessibility of corrective lenses for visual impairment - this statistic could be reduced drastically. Another side yet important aim of this research is to advance frugal science and engineering, the idea termed by Dr. Manu Prakash, a bioengineering professor at Stanford University and the inventor of the Foldscope and Paperfuge, a paper-origami light microscope and paper-based, toy-like centrifuge respectively (Cybulski, 2014). Frugal science is the idea of making high-powered scientific tools more accessible to financially poorer communities as well as more portable and cheap while still maintaining a high efficiency. In other third world nations as well as poorer areas of developed countries, one issue which may exist is the lack of optical tools to correct, clarify, and magnify vision. Even within a developed country like the US, the presence of some lack of affordability of common optical corrective lenses such as glasses and contact lenses exists.

Q12.
What audiences does this problem impact to warrant academic research? Who cares? List at least 5.
Think broadly on potential audiences—there are some that will be people and some that might be environmental or corporate.*

People who cannot afford the price tag on corrective lenses; low-income, poverty-stricken communities and third-world countries Medical Industries (ophthalmologists, optometrists) Businesses Related to Healthcare (Government-sponsored health care programs, private health insurance companies) Eyeglass and Vision Assistance Companies/Manufacturers (Industry) Higher Education (University Research, Graduate Research) Technology and Engineering Research Sectors (Materials Science, Polymer Chemistry, Bioengineering/Biology of the Eye and Vision, Physics of Optics, 3D Printing Engineering)

Q13.
Gain an understanding of the fundamentals of the problem you described by conducting a brief, preliminary literature review.
Describe existing research and current solutions
You must use at least 2 scholarly references (e.g academic journals, primary sources, etc.)
Explicitly state how these references are related to the project overall.
Think about it: How did the article inform your research questions and understanding of the problem?*

Digital Light Processing (DLP) 3D printing is an emerging 3D printing technology that promises faster, higher resolution prints through UV curing of certain polymers. Current DLP technology is based around liquid resins that rapidly cure when exposed to UV light (Wang, 2017). DLP printing does allow for a wide scale of printing resolution from the sub-micro level to much larger sizes as well. Current limitations on this process of printing include a necessity to add colored dyes to the resin to ensure resolution, which can result in an opaque print and fixed mechanical properties such as Young’s Modulus, or how easily an object deforms under stress (Patel, 2017). Other methods specifically for printing lenses are far and few between, with neither the cost, speed, or resolution benefits of DLP printing. In addition, the idea of printing precision optical lenses itself is an emerging field, with many of the feasible methods patented and not transparent to the public. Another hurdle is the residual lines that are left when using the DLP printing method, which would seriously hinder potential optical applications due to the requirement of clarity and manufacturing precision (3D Printing Technology Comparison: SLA vs. DLP, 2017). This project would need to consider extensive post processing such as sanding to finish the lenses to our satisfaction, which would inherently increase costs. A major part of this project would be to refine the printed lenses as much as possible while minimizing resource and time cost, or connected to the aim of frugal science and engineering. Vision problems generally stem from issues in the alignment of the cornea of the eye. In cases of nearsightedness, otherwise known as myopia, the cornea is stretched too wide and light is focused in front of the retina (Facts About Myopia, National Eye Institute (NEI), n.d.). In farsightedness, the opposite occurs. Corrective lenses are carefully calibrated to adjust the curvature of the light entering the eye so that it is properly focused upon striking the retina. In order to successfully print optical lenses, we must be able to personalize the curvature of the lenses to reflect the unique impairments to each afflicted individual’s vision at a level of precision comparable to existing options. Additional research will need to be conducted on how we can adapt existing diagnosis techniques to 3-D printing software. Then, the question of what 1) what polymers are and 2) what polymer could be used must be proposed. As a high school intern, one of the coauthors, Lauren Cho did a research internship at the University of Maryland, Baltimore County Department of Chemistry and Biochemistry under the direction of Dr. Minjoung Kyoung. From compiling research and experimenting on curing polymer lens to use ideally in a cheap, portable microscope, PDMS (polydimethysiloxane) was found to be a good polymer to use in lens. PDMS is a commonly used, cheap, relatively nontoxic, highly viscous polymer that can be used to make optical lens for microscopes (Cho, 2017). A polymer is a class of macromolecule materials which are synthesized from smaller monomers in polymerization reactions (Scientific Principles, n.d.). Curing PDMS is also a polymerization process, typically using a 10:1 elastomer base to curing agent ratio (Cho, 2017; Lee, 2014). As described previously, the curing process of PDMS can be similar to either type of polymerization, addition or condensation, as the process uses cross-linking of the siloxane base oligomers with the presence of the curing agent, or the free-radical catalyst. Also, no byproducts are created, and all base and curing agent molecules should be used by the reaction even if the curing agent to base ratio is slightly altered. Finally, the curing process is slow, so heating PDMS to high temperatures speeds the polymerization process greatly (Cho, 2017). This project proposal, however, seeks to replace this highly tedious and imprecise PDMS curing process at high temperatures to a more efficient process via UV light curing in three-dimensional DLP printing.

Q14. Potential research question(s):*

How can we make optical lenses more affordable, efficient, and accessible through UV DLP 3D printing technology? What cheap, yet durable polymer materials can be used to best optimize the optical properties of lenses such as glasses, contacts, microscope lenses, magnifying glasses, and camera lenses? If contact lens or other lenses to be placed on human eyes or skin, is it safe and compatible with the human eye? Is it possible to capture the precision required for corrective lenses with current technology?

Q15.
Based on the preliminary literature review, how might you approach the problem described? Think of at least 5 different approaches to solve the problem.
Consider each of the audience's perspectives to tailor a specific approach.
Consider using "How might we" statements to guide your solutions.*

How can we make DLP UV printing more precise in optical lens shape for greater precision? How can we utilize SLA printing to make more intricate lenses with even more precision? Can we use this technology to make glasses more durable by also 3D printing framing materials like nylon? How might this device enable people to fix their own eyewear rather than relying on costly replacements? How might we tailor this technology for people with other eye disorders or needs (ie astigmatism, bifocals) which may otherwise prevent them from receiving proper eyewear for eye treatment?

Q16. Comment on this project's feasibility.*

This Gemstone project could be very much feasible in terms of achievable end-term goals in product creation. First off, UV DLP 3-D printing is technology that already exists and has been used to create products. Also, UV light can be used to cure polymers in the polymerization curing process of an elastomer base and curing agent. Polydimethylsiloxane, or PDMS, is a potential transparent, low-hazard, cheap and readily available polymer which could be used for optical lenses, as one of the coauthors, Lauren Cho, has used the material in her research project last year as a high school intern at UMBC Department of Chemistry and Biochemistry (Cho, 2017). The use of PDMS in optical devices has been done before, as in Dr. Steve Lee of Australia National University's research on hanging droplet lens, which basically consists of putting a PDMS base and curing agent droplet mixture on a microscope slide and then inverting it in an oven to cure a naturally-created semi-spherical lens (Lee, 2014). Hence, with previous use and experimentation on PDMS in terms of curing optical lenses under hear, using PDMS as the material under UV light for the creation of 3D printed optical lenses is very much feasible.

Q17. List the names and positions of at least two experts, with at least one from on-campus, who could review your project. *

Dr. John Fourkas is a professor in the chemistry department who is interested in nonlinear optical microscopy research as well as nontraditional approaches to micro- and nanofabrication. Dr. Don DeVoe is a professor of mechanical engineering who focuses on nanoprinting microfluids for biomedical use. He would be a great advisor for his knowledge of soft materials as well as his ability to apply these to biological systems. (http://mems.umd.edu/ddev/)

Q18. Record a 30-60 second advertisement for your topic. Make this video something that would entice your fellow classmates to be curious about and interested in your topic—this should convince classmates to make your idea into a Gemstone team! Use your creative ideas here to make this as enticing as possible. This video will be used during various times throughout the semester to quickly and succinctly "plug" your topic/idea for a follow-up. Post the link here. *

https://youtu.be/DphC3m1uYeQ

Q19. You may upload any additional information here.

Lauren_ChoSynthesisPaperFinalDraft4thQtr (1).docx.pdf
805.1KB
application/pdf

Location Data

Location: (38.980697631836, -76.936897277832)

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