

Contact Lens Manufacturing System for Colorblindness Correction

Problem Definition & Objective

Roughly eight percent of males and one percent of females are affected by some form of colour vision deficiency. Colorblindness correcting sunglasses currently exist but are not practical as a means of seeing color all the time, especially indoors.

Colorsmith is a Halifax-based company developing contact lenses to correct red-green colorblindness, which is the most prevalent type of colorblindness. Colorsmith has proof of concept for the colorblind corrective technology; however, the next step is to utilize their technology in an actual contact lens.

The objective of this project is to create a system that can manufacture planar (zero magnification) contact lenses. These lenses will be used to test the inclusion of colorsmith's colorblindness corrective technology.

Requirements

- The contact lenses shall be planar (zero magnification).
- The lenses shall be 14-15 mm in diameter with nominal tolerance of ± 0.05 mm.
- The lenses should have a surface finish of at least $50 \mu\text{m}$ (these will not be wearable but can be used as proof of concept for colorsmith's solution).
- The IMM shall be bench-top mounted with a footprint of 4 ft^2 or less.
- The IMM system shall weigh less than 30 lbs.
- The system shall be user friendly and come with a standard operating procedure.
- The manufacturing system shall be functional at temperatures ranging from 10°C to 35°C .

The Future of the Machine

- Upon completion of this design project, colorsmith will continue developing their contact lens manufacturing system by acquiring dies with an appropriate surface finish to produce quality, medical-grade contact lenses.
- The contact lens manufacturing system will also require colorsmith to purchase an ultraviolet (UV) oven to cure the experimental lenses.
- These additional processes will allow colorsmith to confirm that their solution can be formed into a usable contact lens shape that is safe for the user to wear.
- The end goal for colorsmith is to have the capability to manufacture their own functional and safe planar red-green colorblindness corrective contact lenses without relying on external sources. Therefore they will be able to keep costs and lead times down while developing this innovative new technology.

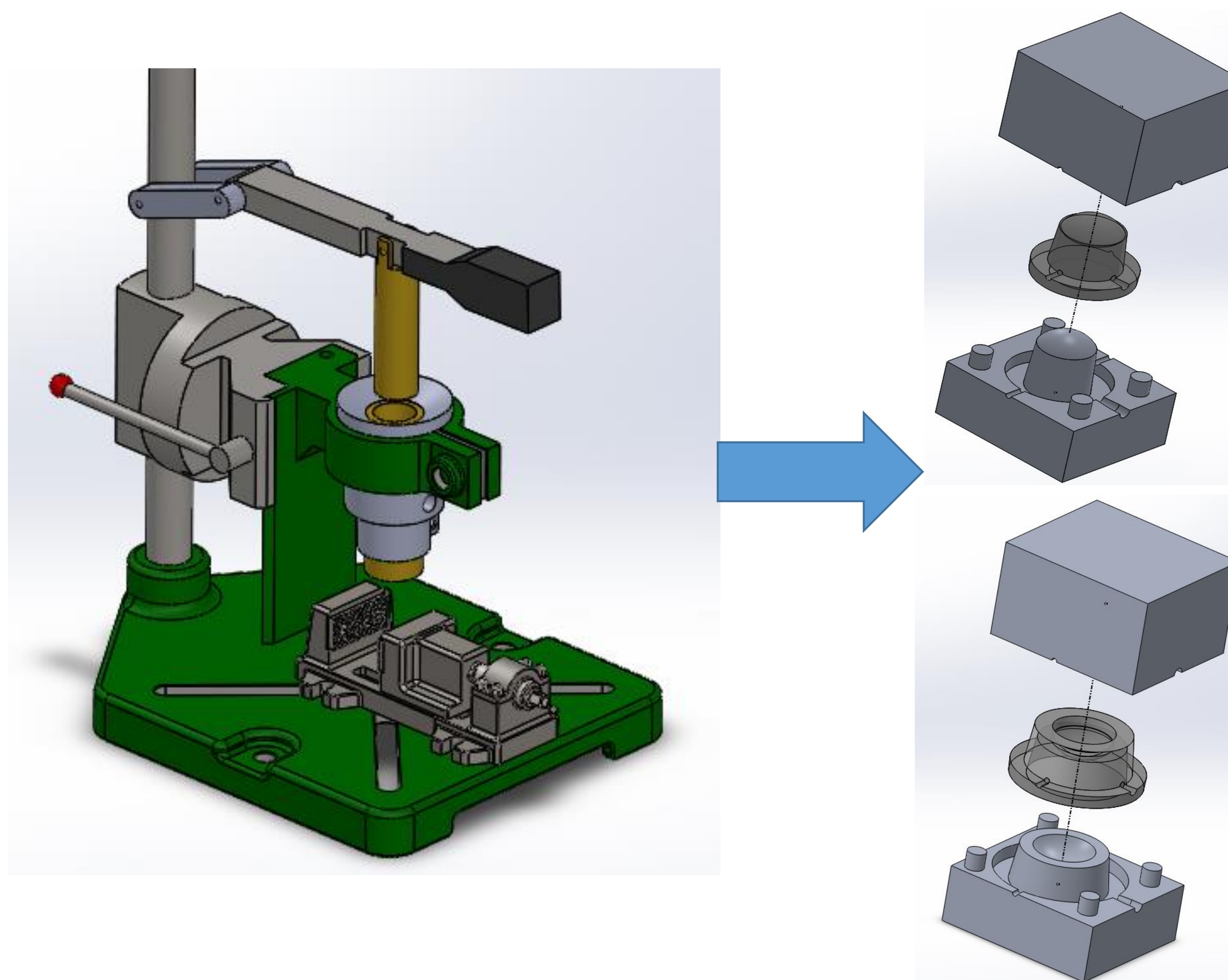
Injection Molding System

Injection Molding Machine (IMM)

- IMM consists of an injection molding gun (IMG), framework, and electrical/heating components.
- IMG consists of:
 - Hollow brass cylinder with nozzle.
 - Reciprocally sized brass piston fitted inside cylinder.
 - Funnel at the top for inserting plastic pellets.
- All IMG parts made from brass to resist wear and scratching and for equal expansion when heated.
- Frame secures IMG and connects piston to a lever mechanism for use with various sized molds.
- Molds are mounted in a vice to maintain compression during injection.
- Electrical components mounted inside steel enclosure fixed next to machine.
 - PID temperature controller, steady-state-relay, and on/off switch.
 - Type-T thermocouple and 125 W heating band attached to PID extend outside enclosure and onto IMG.
 - Thermocouple inserts into threaded hole in barrel and heating band is fixed around lower portion of barrel.
- Power provided by standard AC wall outlet.

Contact Lens Molds

- Contact lenses formed in polypropylene homopolymer molds for lens curing in UV oven.
- Mold Features:
 - Thin-walls for Ultraviolet (UV) penetration to cure lenses.
 - Interference fit between mold halves to maintain compression.
 - Cut-off point to prevent excess solution from distorting contact lens profile.
- Molds are formed using aluminum dies.
- Die features:
 - Injection hole where IMM mounts.
 - Drainage holes so operator can tell when dies are full.
 - Alignment pins to hold the die halves together in correct orientation.
 - Lens surface on dies is an order of magnitude greater than desired lens surface finish to achieve required finish.



Costs

Part	Price (CAD) (Including shipping + taxes)
Frame	\$94.90
Heating Band	\$55.76
Temperature Control + Type-T Thermocouple + SS-Relay	\$63.59
Brass Stock	\$43.50
Electrical Enclosure	\$24.50
On/Off Switch	\$0.93
Total	\$283.18

References & Acknowledgments

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Advantages and disadvantages of injection moulding. (2016, June 13). Retrieved, from <http://www.martins-rubber.co.uk>

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