Mechatronics - Group 42
Aggash Sivasothy
Matthew Yuen
Prabhdeep Soni
Vishvam Mazumdar
Vishwa Sheth

Automated PCB Disassembler

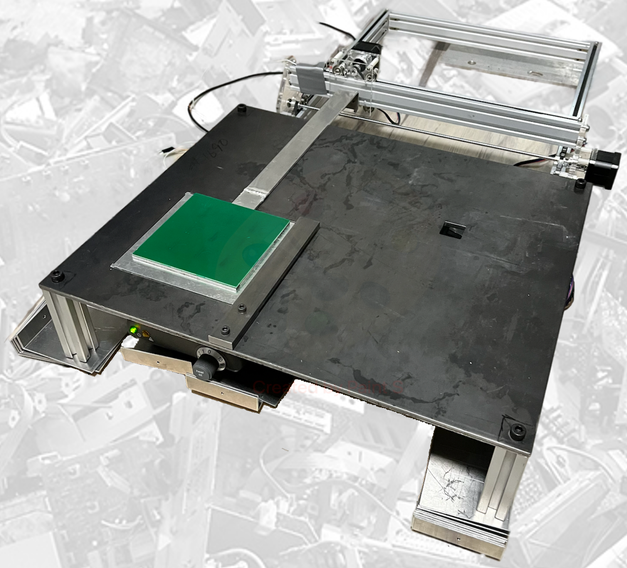
UNIVERSITY OF WATERLOO
FACULTY OF ENGINEERING
Department of Mechanical & Mechatronics Engineering

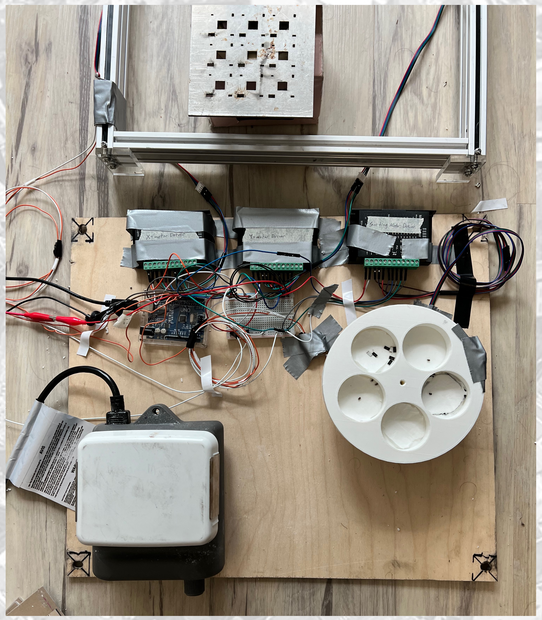
Background

- The world produced 53.6 million tonnes of e-waste in 2020 yet only 17.4% of this was recycled
- Many PCBs end up directly in landfills due to costs and time associated with disassembling
  - Issue has a two-fold impact, contributes to the growing amount of e-waste
  - Also results in components continuing to be manufactured even though many could be directly re-used if properly desoldered

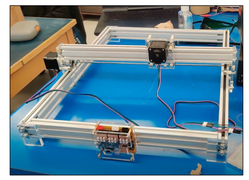
Objective

Design and build a machine or process that can desolder a used PCB in order to remove and sort as many microelectronic components as possible. These components include but are not limited to resistors, capacitors, inductors, transistors and ICs.

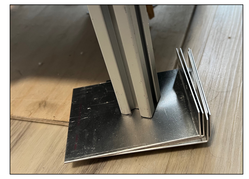




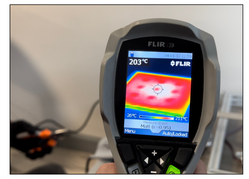
Challenges



Uneven actuation along the two-axis machine
Counter-measured by upgrading stepper motor drivers



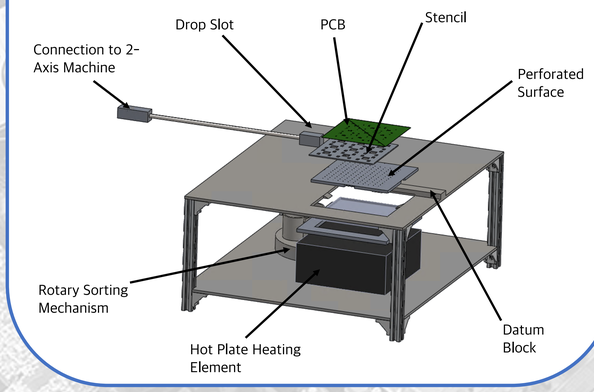
Insufficient contact with the heating element
Fixed with shims to correct levelling



Heat loss to main platform
Mitigated using a slotted seating mechanism to minimize contact area

Implementation

- Desolders components using a laboratory-grade hot plate
- Heat is transferred indirectly through a custom stencil that is in contact with the PCB
- Entire stencil is actuated to wedge the components off the PCB using a datum block
- Stencil is then actuated to a drop slot in the platform with a rotary bin mechanism below
- Limit switches are used to centre 2-axis machine and rotary sorting mechanism
- Controlled by an Arduino Mega

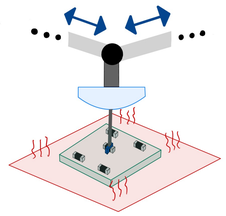


Process Flow

Reset to Home Position → Load PCB → Desolder → Separate PCB → Actuate to Drop Slot → Rotary Sorting → Unload

Design Alternatives

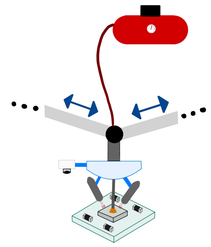
Lower Heating Element + Mechanical Gripper



Benefits
- Batch desoldering

Drawbacks
- Part picking time
- Direct heating may damage PCB

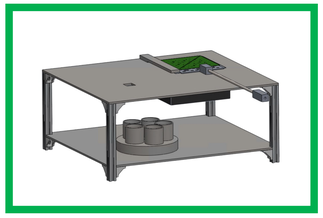
Heat Guns + Pneumatic Suction + Machine Vision



Benefits
- Board compatibility

Drawbacks
- Machine vision reliability
- Power draw due to lossy heat guns + compressor

PCB-Specific Heated Stencil + Drop Slot



Benefits
- Batch desoldering
- Lowest device cost

Drawbacks
- Different stencils for different PCBs

Results

Objective	Target	Result
Ease of development	N/A	✓
Maximize compatibility	N/A	✓
Minimize time to remove components	10 minutes	7 minutes
Maximize sorting accuracy	100%	>80%
Minimize peak power usage	1250 W	350 W
Minimize required human intervention	N/A	✓

Constraints	Target	Met?
Component weight	<5 g	[0.010 g, 0.0513 g]
Size of components	[1.25 mm x 2 mm, 6.3 mm x 3.2 mm]	[1.25 mm x 2 mm, 6.3 mm x 3.2 mm]
Board footprint	[3" x 3", 12" x 12"]	5" x 5" with more capacity
Minimize component damage	>75% function	>91%
Attainable heating element temperature	400°C	550°C

Acknowledgements
Prof. Andrew Kennings
Prof. Behrad Khamesee
Prof. Rodolfo Pellizzoni