Product Validation, Electrical Design, and NRTL Listing



A practical guide to product safety for entrepreneurs and small businesses.

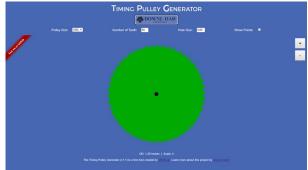
www.makesafetools.com

scott@makesafetools.com

(415) 937-1808

Experience





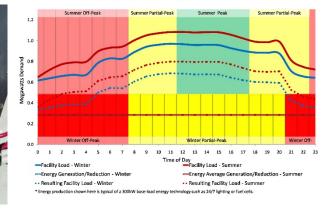








Annual Average Daily Load Profile - by Hour, Season, & TOU Period









Shop Class







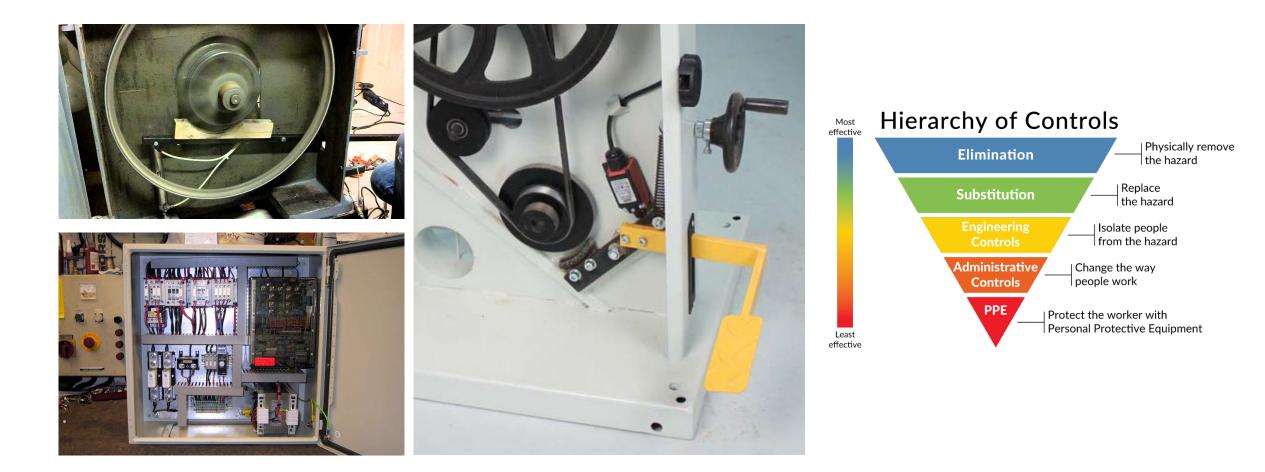
Newton's First Law



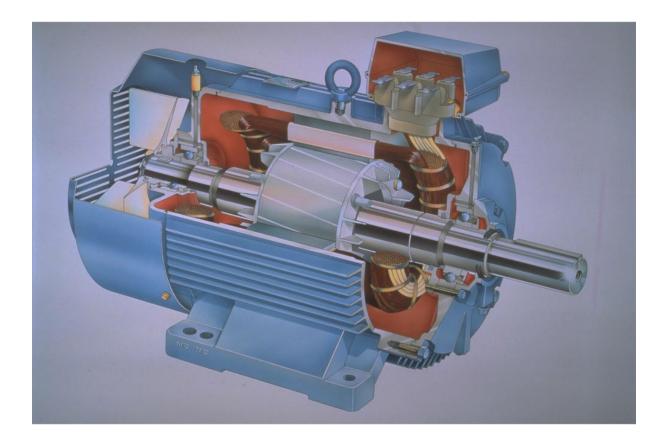




Exploration of Braking



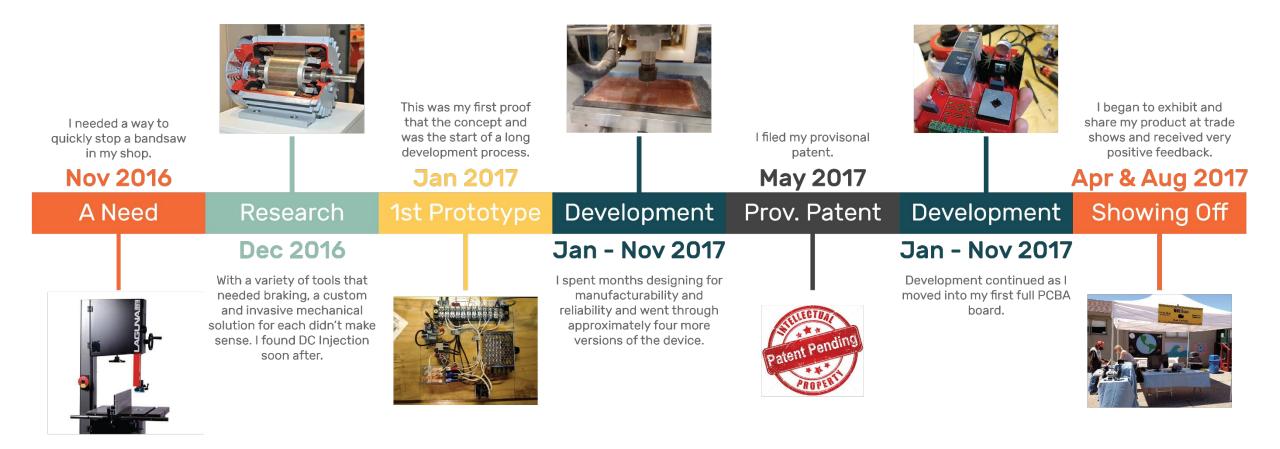
DC Injection



Prototyping

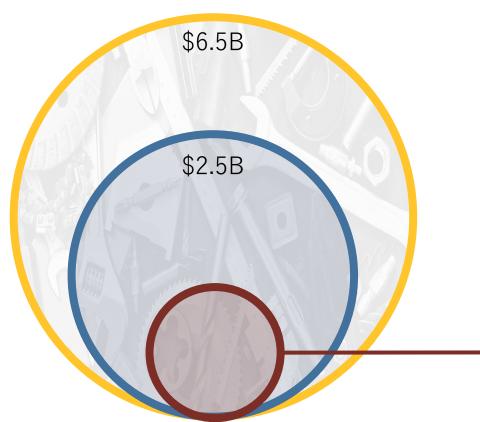


First Steps



A Business?





600,000 Global Manufacturing Firms 12.5MM At-Risk Tools

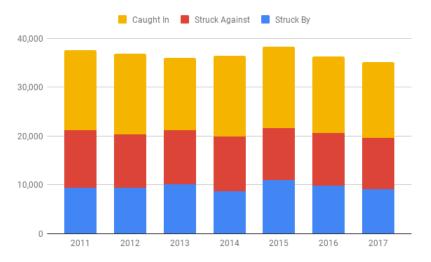
251,000 U.S. Manufacturing Firms 5MM At-Risk Tools

40,000 U.S. Manufacturers (Actively Mitigating Risk) 700K At-Risk Tools

7/16/2020

Injury Profiles

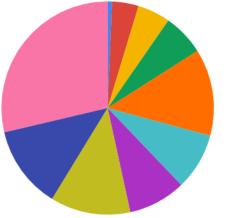
Injuries Over Time



Number of nonfatal occupational injuries and illnesses involving days away from work by [all] workers, All U.S., all ownerships, 2011 – 2017.

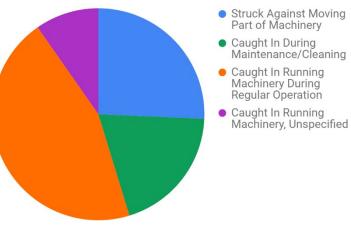
SOURCE: Bureau of Labor Statistics, U.S. Department of Labor, Jul 6, 2019

Injuries by Machine



- Threading and Tapping
- Lathes
- Extruding, Injecting, Forming, Molding
- Sawing
- Other
- Boring, Drilling, Planing, & Milling
- Bending, Rolling, & Shaping
- Presses
- Grinding & Polishing
- Unreported

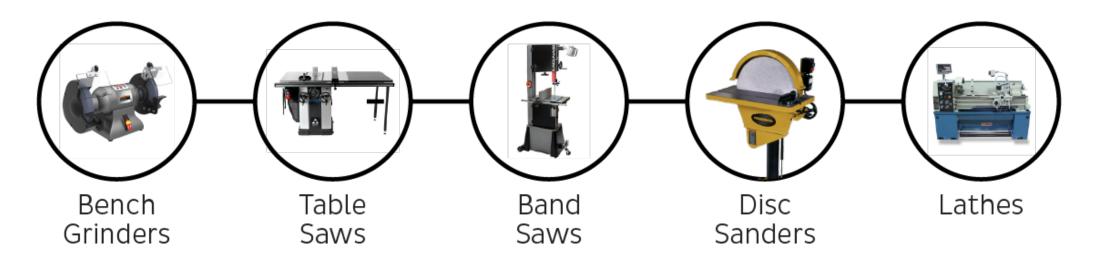
Injuries by Operation



7/16/2020

Recurring Hazards

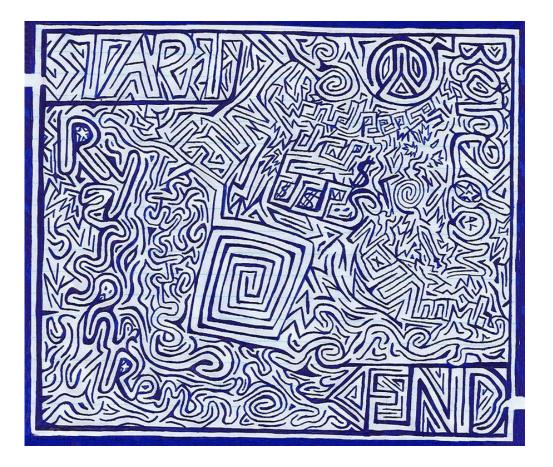
- The Control of Hazardous Energy (Lockout Tagout)
- Accidental Restart
- Coasting
- Emergency Situations & E-Stop
- And more ...



Disclaimer

- This was a learning process.
- I'm sharing what I tried and what I did ... that doesn't mean it's what you should do.
- Use your head when trying things on your own or building your own test equipment.
- Don't give-in to imposter syndrome.
- Learn a ton about your product!

What's a Nurtle?



NRTL Struggles:

- Identifying the relevant standard(s)
- Paying for standards!?
- Being stuck *in-between*
- Customer disservice
- Requirements vs. best practices
- Misleading listings and the longest path to nowhere.

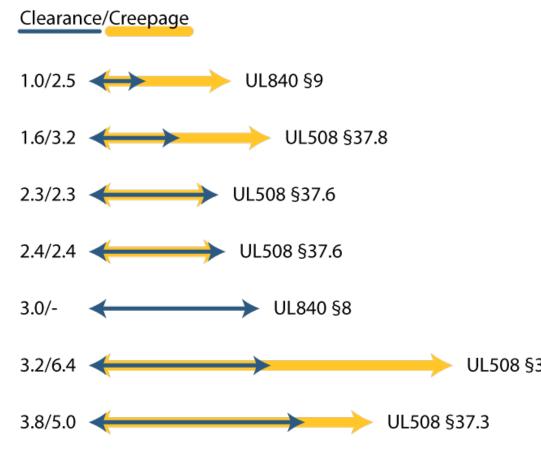


OSHA Fed/OSHA is the regulating body that oversees and regulates NRTLs.

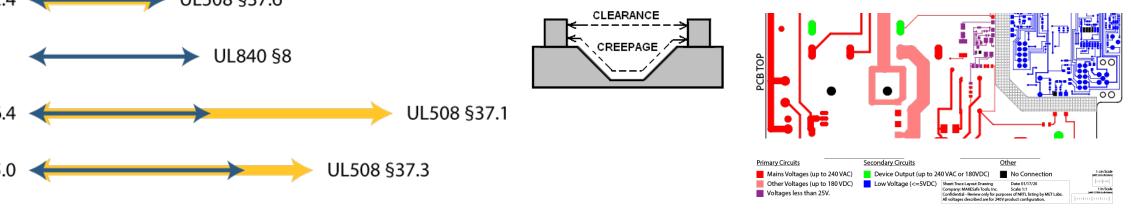
Standards and Tests

- UL508 vs UL508A Industrial Motor Controls
- Primary Tests: Temperature/Endurance, Short Circuit, Dielectric
- Other Tests: Push Back, Strain Relief, Marking Durability, Leakage Current, Spacing
- Product definition vs. existing products & existing standards

Clearance & Creepage



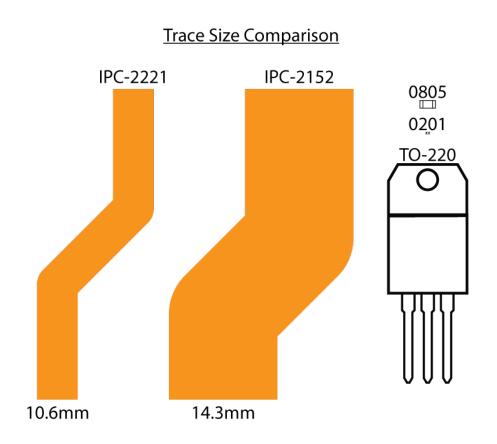
- UL508 vs. UL840
- Buying another standard
- Pollution Degree, Overvoltage Category, and PCB Type, CTI, etc.
- Secondary / SEL Area



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Trace Width

- Voltage drop, temperature rise, routing, and real estate
- IPC-2221B vs. IPC-2152
- Diminishing returns for trace width.
- Planes, internal/external, etc.
- For example (20 amps, 3" of 2oz copper, 25°C temp rise):
 - IPC2221: 211 mils (most calculators & tables)
 - IPC-2152: 560 mills (my application)
- Saturn PCB Toolkit
- UltraCad Calculators
- <u>https://www.smps.us/pcb-calculator.html</u>



How to power it?

- Needed:
 - 3Ø 240V supply, 7kW capacity, 100% duty cycle
- Available:
 - A single 120V residential receptacle
- Solution:
 - Install 240V sub-panel in lab with independent feeder from main service panel.
 - Install and balance rotary phase converter.
 - Install delta-wye variacs to balance phases by hand.



How to load it?

- Needed:
 - 3Ø 240V loads, AC/DC tolerant, 7kW capacity, 100% duty cycle
- Available:
 - <\$500
- Solution:
 - Calculations & Google-fu
 - Surplus inductors
 - Modified industrial heater
 - Misc. controls
 - A window

	Frequency	60						
2	Power Factor	0.60						
Inputs	Voltage	240		Indiv. Part				
-	Current (Amps)	8.8	Two in Series	Two in Parallel	Three in Series	Three in Parallel	Four in Series	Four in Parallel
	Apparent Power (VA)	2,112						
	True Power (W)	1,267	634	634	422	422	158	158
Outputs	Z (Ohms)	27.27						
	Resistance (Ohms)	16.36	8.2	32.7	5.5	49.1	8.2	130.9
Ŭ	Reactance (X)	21.82						
	Inductance (mH)	57.9						
			211	211	141	141	53	53
e	Voltage Across R	144	72	144	48	144	36	144
sing Guide	Listed "Power Rating" of R @120V, for impedance selection.	880	1,760	440	2,640	293	1,760	110
Purchas	Listed "Power Rating" of R @240V, for impedance selection.	3,520	7,040	1,760	10,560	1,173	7,040	440



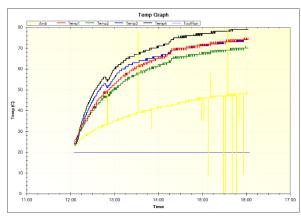


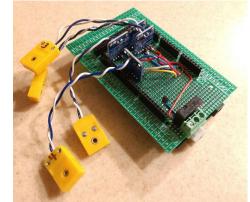
- <u>Specifying Loads</u> for Shopping
- PTC Heaters
- Fin Heaters
- Enclosures & Operator
 Safety

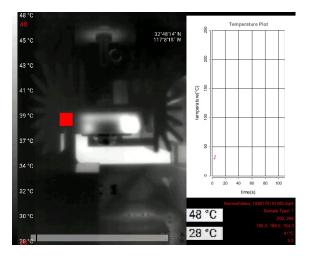


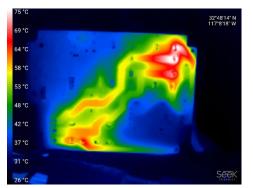
How to measure it?

- Needed:
 - 5+ test points (temperature)
 - 2+ test points (V/I)
 - Logging & visualization
 - A heated test chamber
- Available:
 - An Arduino
 - A pile of thermocouples
 - A cheap thermal camera
 - A small room and a big load

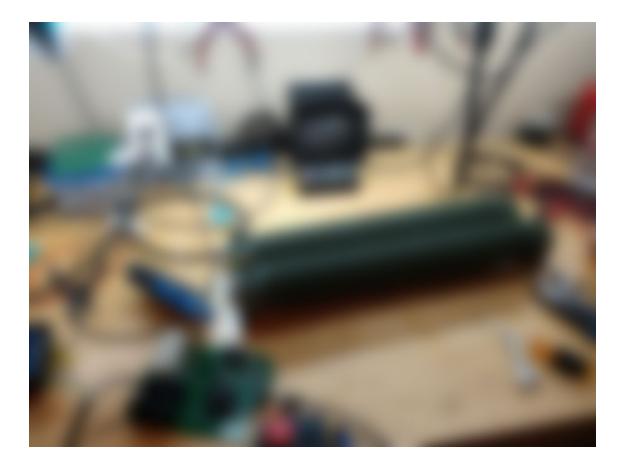


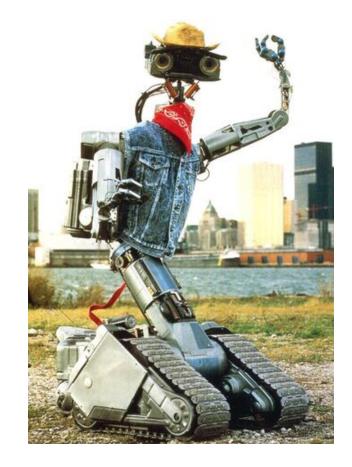






Short Circuit





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Dielectric

- Listed spacings.
- NRTL listed parts.
- plastic enclosure + SEL isolation.
- electrophoresis power supply and isolated current measurement.





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Labels. Ugh.

- UL 94
- Marking Durability
- Cost & Volume
- Alcohol Swab

	ESAFE [®]
	OOI Brake
	Emergency Stop, and Motor Braking)
MODEL & RATINGS	WARNING This industrial control complies with: ULS08
□ PTB-V120-P1-(*) 120VAC, 1Φ, 60 Hz, 1.5 HP □ PTB-V240-P1-(*) 240VAC, 1Φ, 60 Hz, 3.0 HP	Complete the compatability checklist before plugging anything into this device. CSA C22.2 No. 14-13. E114885 CSA C22.2 No. 14-13. SCCR: SkA Enclosure: UL Type 1
 PTB-V240-P3-(*) 240VAC, 3Φ, 60 Hz, 5.0 HP 	Designed and Manufactured in San Diego, CA 921 the USA by MAKESafe Tools, Inc. (415) 937-18



Test Considerations

- Cost
- Shipping
- Usability
- Durability
- Test operator safety
- Documentation
- Software



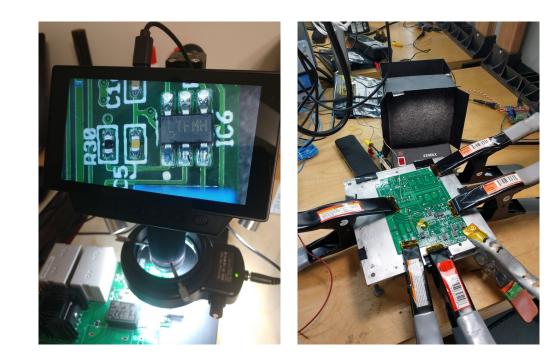
Failure Analysis

- Requirement vs. Good Practice
- Inductive Loads
- Inductive Micro-Loads

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Design Considerations

- Manufacturability
 - PCB cleaning
 - Solder-waveability
 - Dialetric testing
 - Inspections
 - Tooling & indexing
 - Torque standards







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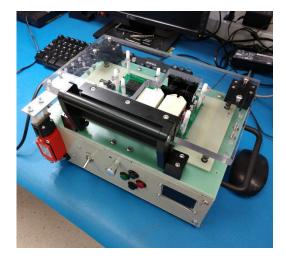
Production-Line Testing

- Function PCB Testing
 - Operator Safety
 - Test Reliability
 - Data Logging

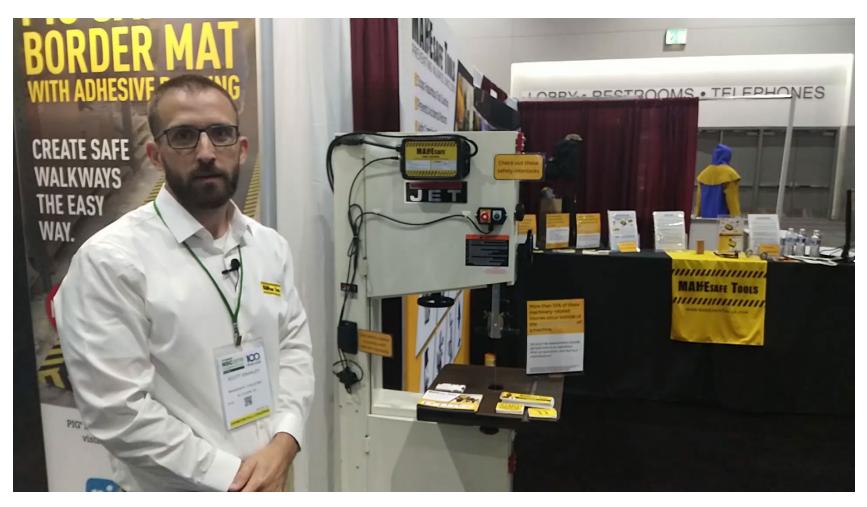








Bandsaw Demo



Thanks & Questions!?

- Visit us at <u>www.makesafetools.com</u>
- Learn more about CAL/OSHA petition 580: <u>https://www.makesafetools.com/unexpected-startups-how-osha-petition-580-seeks-to-protect-workers/</u>

- Contact me:
 - <u>scott@makesafetools.com</u>
 - (415) 937-1808

