What Happens When An Engineer Gets

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Bedbugs

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MHV Linux Users Group
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This is Jason Bourne,
the toughest target that you have ever tracked.
He is really good at staying alive, and
trying to kill him and failing…
just pisses him off.

Bedbug Basics

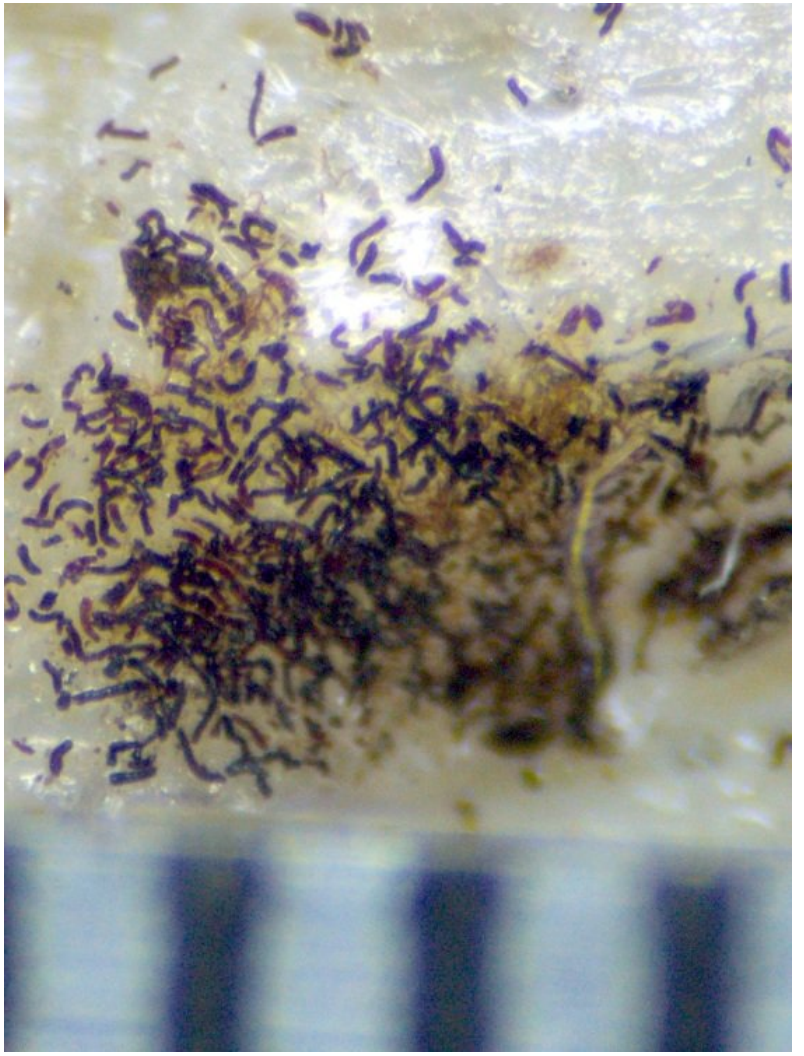
- Obligate hematophage
  - *Not* parasitic
  - Commute to food supply
- *Not* correlated with
  - Wealth / IQ
  - Cleanliness
- *No* DIY pesticides
  - DDT is *not* effective
  - NYS has restrictive rules

How To Get Bedbugs

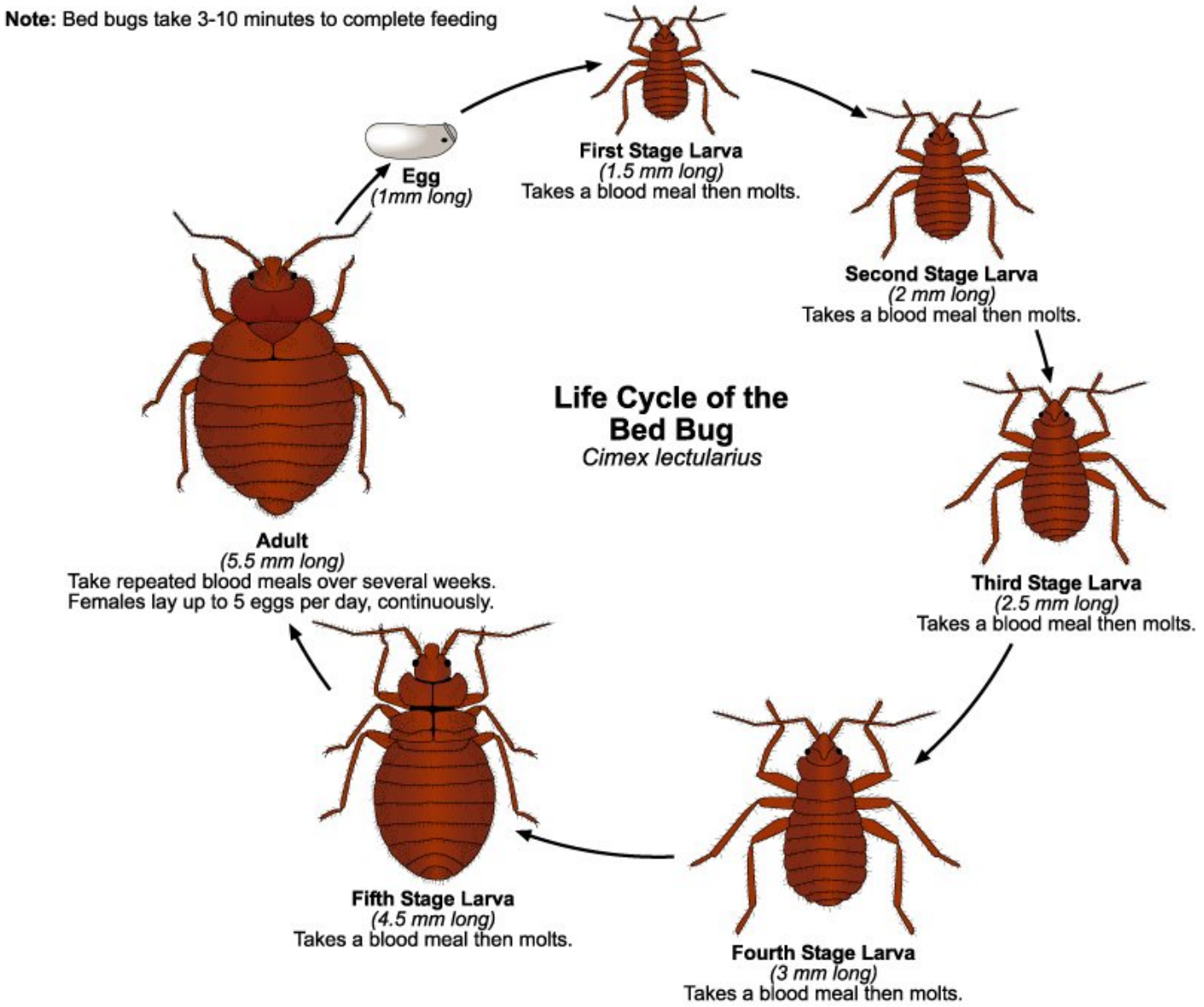
- Go out of your house
  - Motel / hostel
  - Conference Center
  - Transportation
  - Group living: apartments
- Bring something back
  - Luggage
  - Purchases
  - You

Minimum Requirements

- Bed Bug Starter Kit
  - *One* fertilized female *or*
  - A breeding pair
- Blood
  - You
  - Mammalian / avian pets
- Misguided Optimism
  - It can't happen here
  - That's a mosquito bite



Life Cycle



http://extension.entm.purdue.edu/publichealth/images/bedbug/popups/lifecycle.jpg

Timing Is Everything

Egg → Adult
5 larval stages
One month

Good News

Obligate Hematophage

You are *the* food source

Bad News 1

Unfed larvae
survive for
several months

Bad News 2

Unfed adults
can survive
one year

Extremely Bad News

Females lay
≈5 eggs/day
continuously for
≈100 days

Control

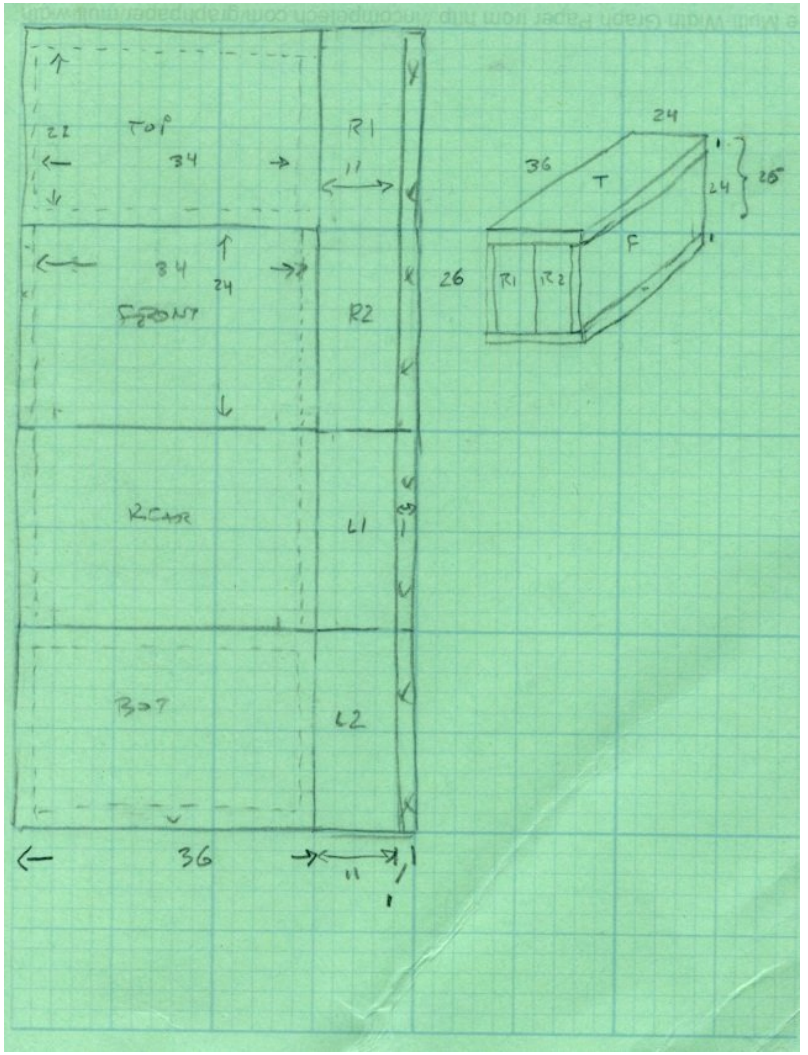
- Hope is not a strategy
- Bedbugs will arrive
  - Already fed
  - Fertilized
  - Ready to rumble
- Kill bedbugs on entry
  - Disinsect *everything*
  - Even you

Killing Bedbugs

- Chemicals
  - *No* DIY pesticides
  - *No* gases
  - Diatomaceous earth
- Thermal
  - ≤ 0 °C or ≥ 50 °C
  - Internal temperatures
  - ≈1 hour soak

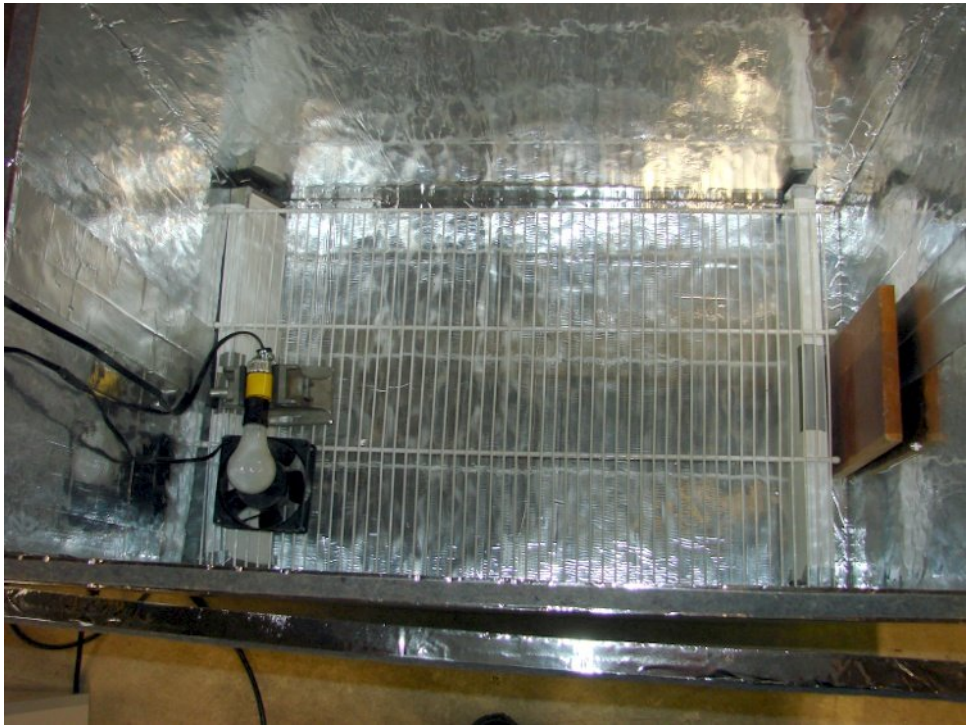
SCIENCE!

- Foam insulating board
  - 1 inch = R 6.5
    - 6.5 ft^2 ● h ● °F / BTU
  - 32 ft^2 surface area
  - 60 °F above ambient
- That's 300 BTU/hr
  - Or, better: 90 W
  - A big tungsten bub!



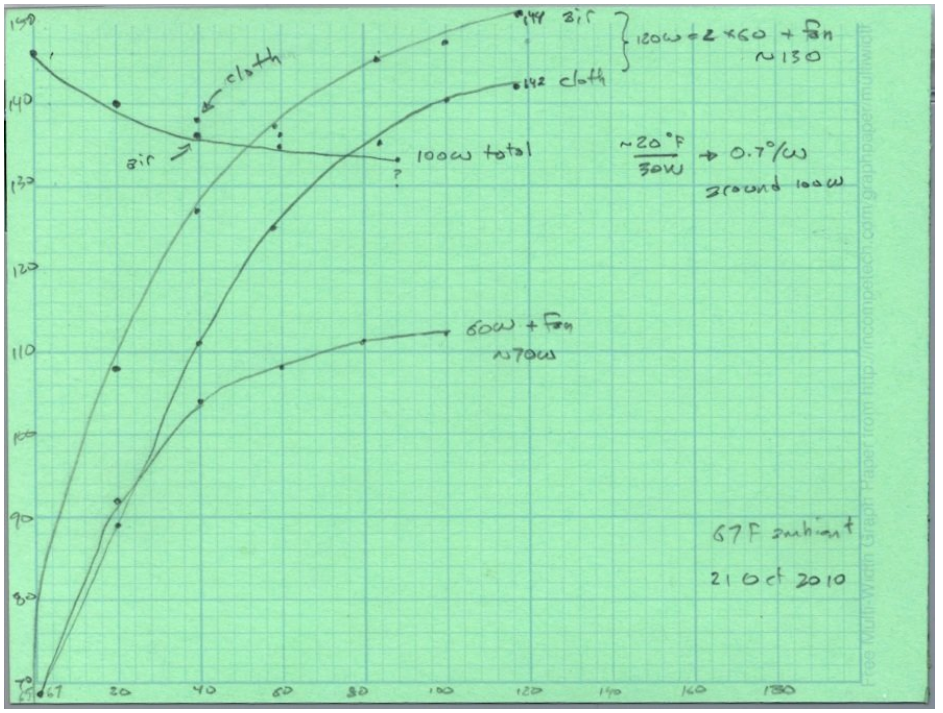
Hot Box Disinsector

- DIY Bare Minimum
  - Foam box
  - 100 W tungsten bulb
  - Muffin fan
  - Wire rack
  - Remote thermometer
- Or Buy One…
  - www.packtite.com
  - $320



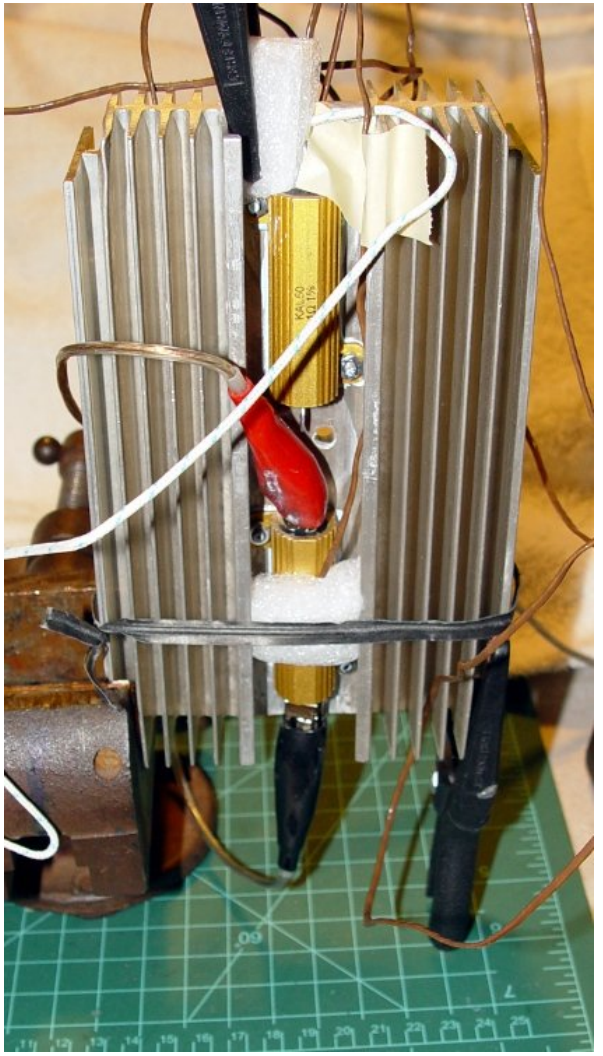
SCIENCE!

- Temperature vs time
  - $T(t) = T_A + T_R(1 - e^{-t/T})$
  - Time constant
  - Final temperature rise
- Measure inside object
  - Bugs move around
  - Seal the box!



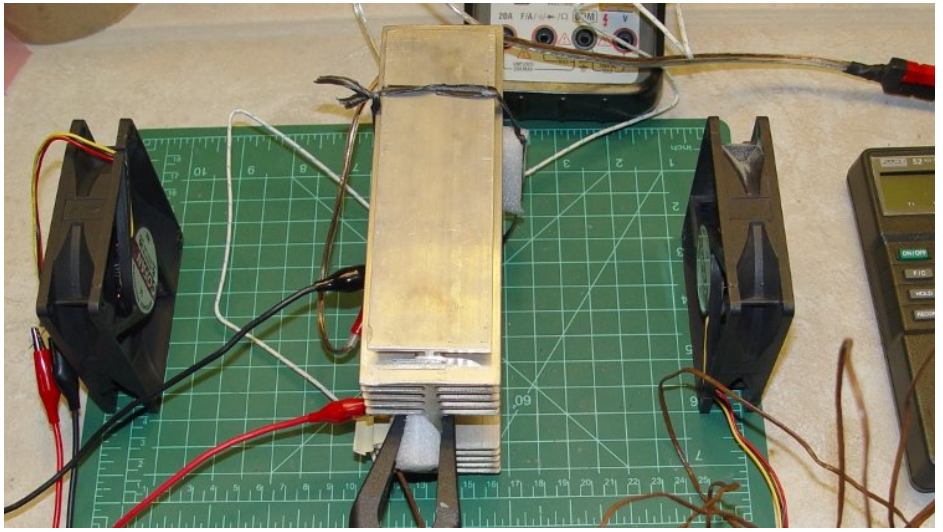
ENGINEERING!

- Power density
  - Watt / volume
- Bulb = wicked hot
  - White heat, in fact
  - Tiny filament
- Larger, cooler heater
  - Power resistors
  - Finned heatsinks
  - Cooling fans



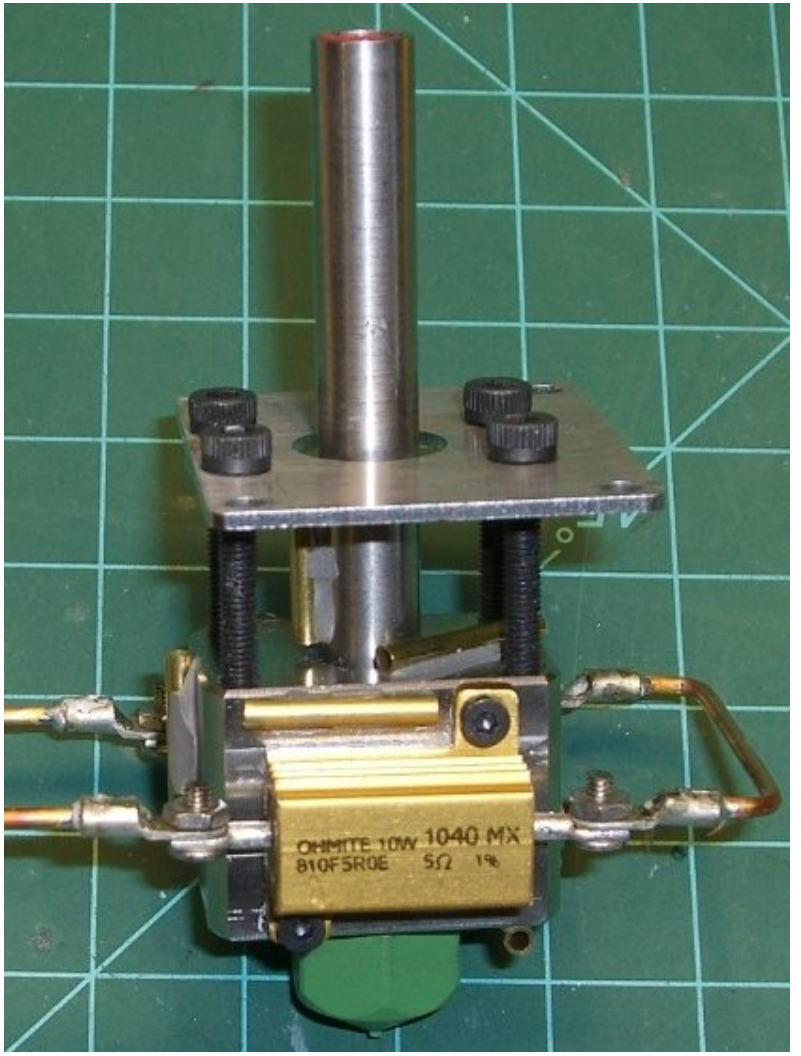
DATA!

- Dissipating 50 W
  - Resistor = 33.9 °C
  - Bottom = 24.9 °C
  - HS = 66 °F = 18.9 °C
  - ΘRB = 0.22 °C/W
  - ΘHA = 0.067 °C/W
- And so forth & so on
- Temperature controller!
  - Heat / soak / cool / alarm …

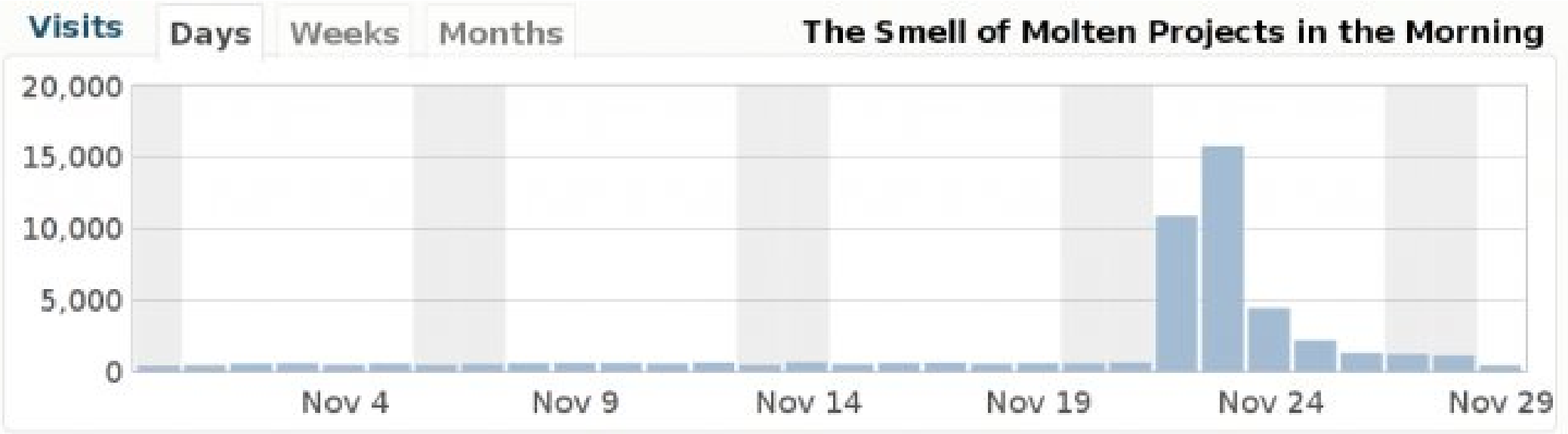


And then...

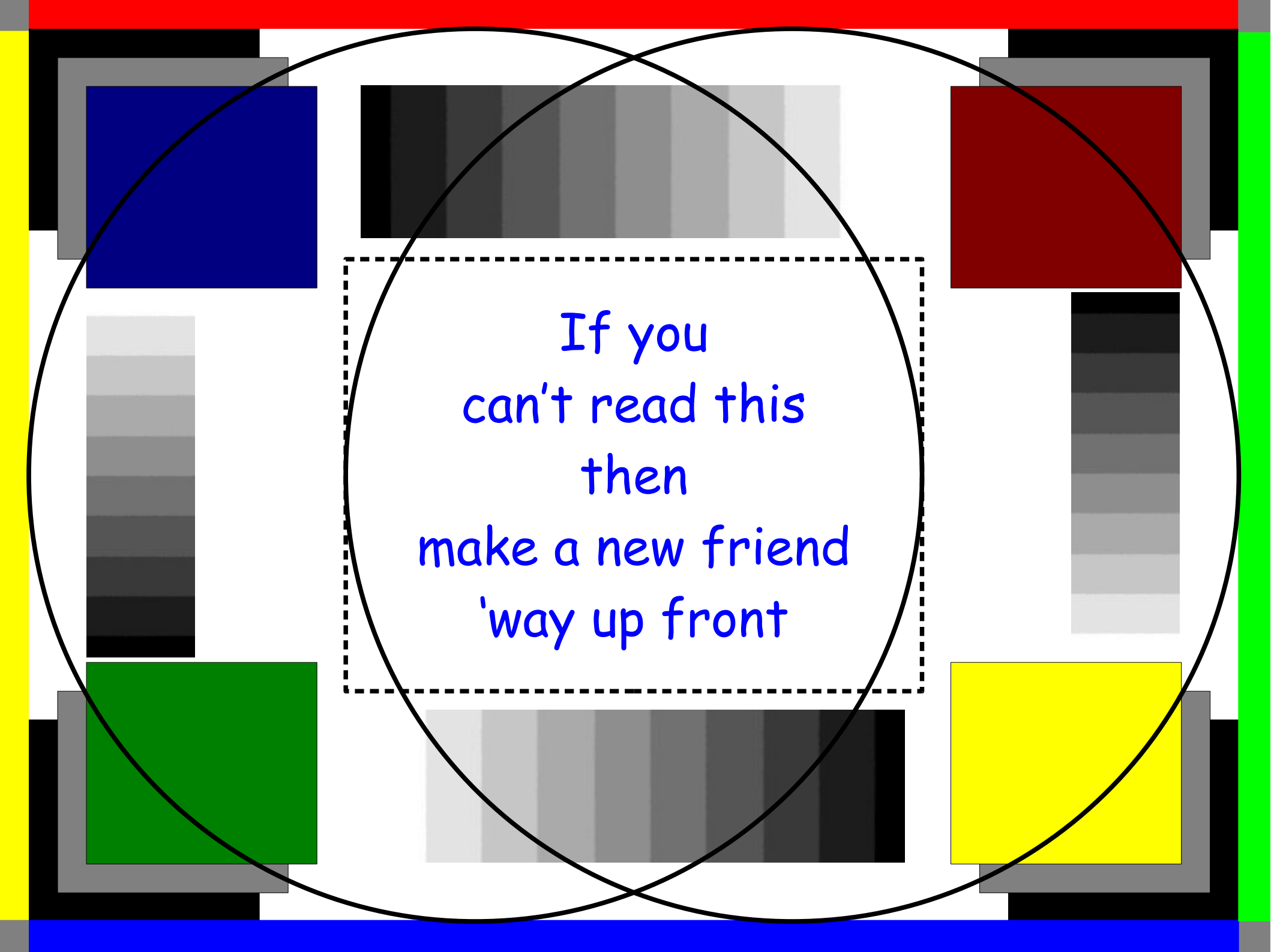
- Thing-O-Matic
  - 3D printing
  - Molten plastic
- Resistors as heaters
  - 30 W in a 10 W bag
  - *Ouch…*
- *MORE SCIENCE!*
  - And common sense



Aftermath



softsolder.com/2010/11/08/bed-bugs-overview
Short link: wp.me/poZKh-1rr


If you
can't read this
then
make a new friend
'way up front