Cleaning Sensitive Electronics

A Hubbard-Hall Presentation

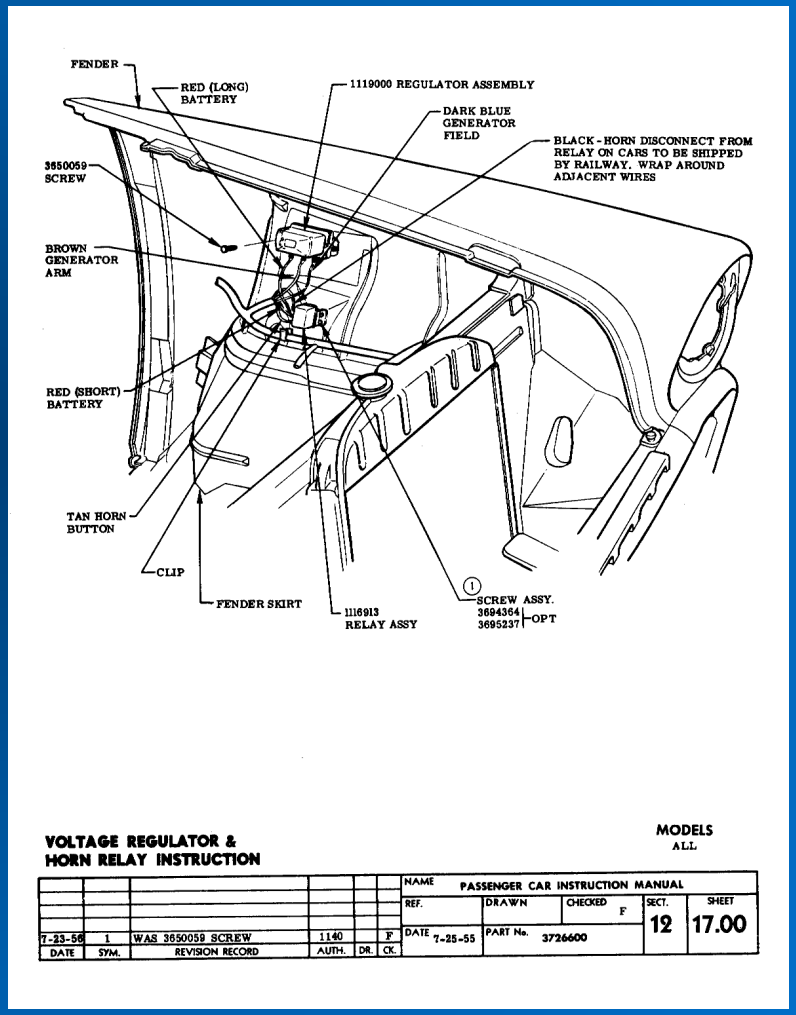
The Importance of Electronics Reman

- Is it worth the effort?
  - What to consider
    - Value – percent of total vehicle
    - Cost – to replace vs. reman
    - Surface to clean – degree of difficulty
    - Contaminants – match the cleaner to the soil
    - Cleaning options – is water the answer?
    - Equipment – best practices
    - Sustainability

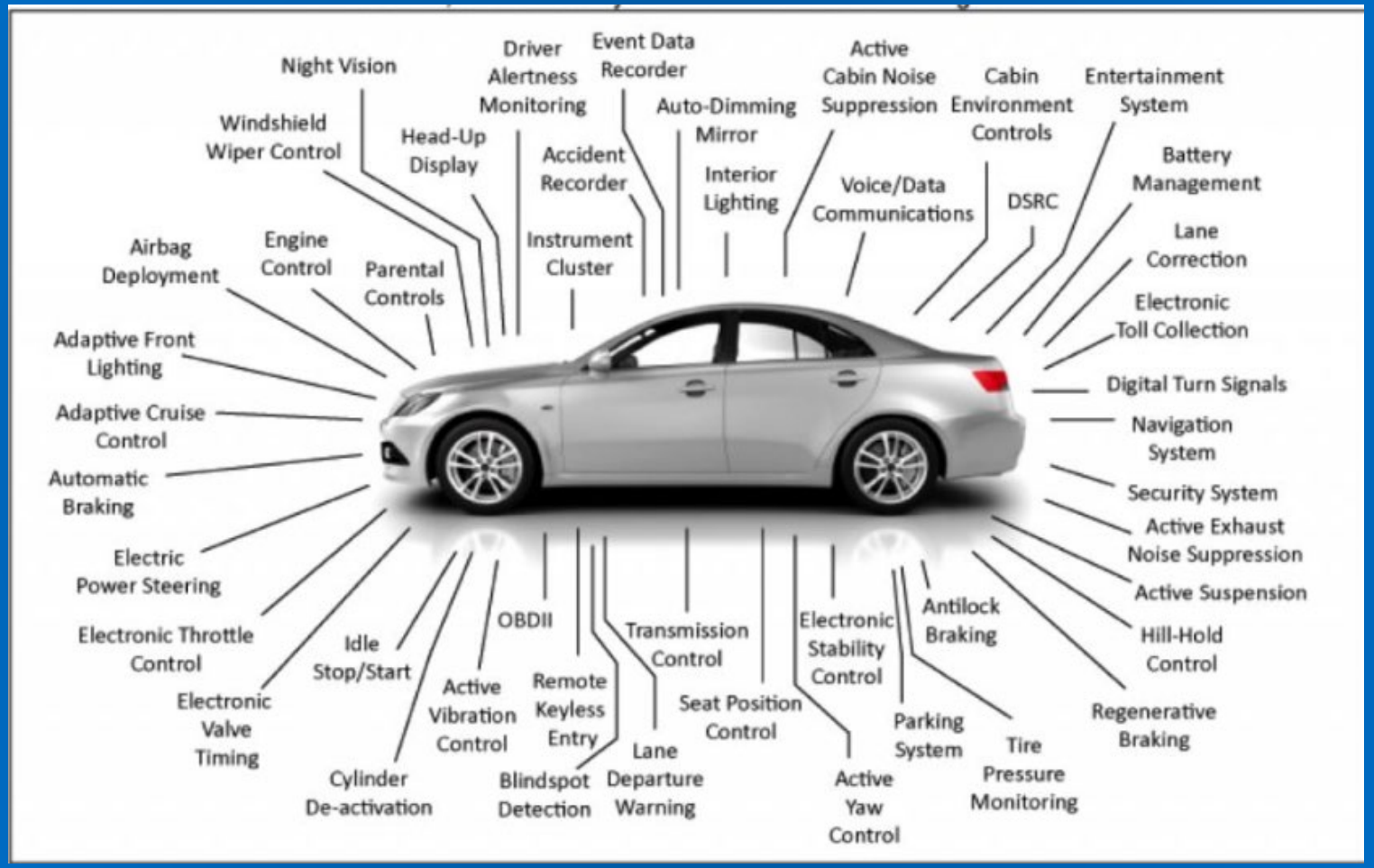
Electronics in vehicles - Then

1957 Chevrolet Belair

- Horn
- Lights
- Radio
- Windshield wipers

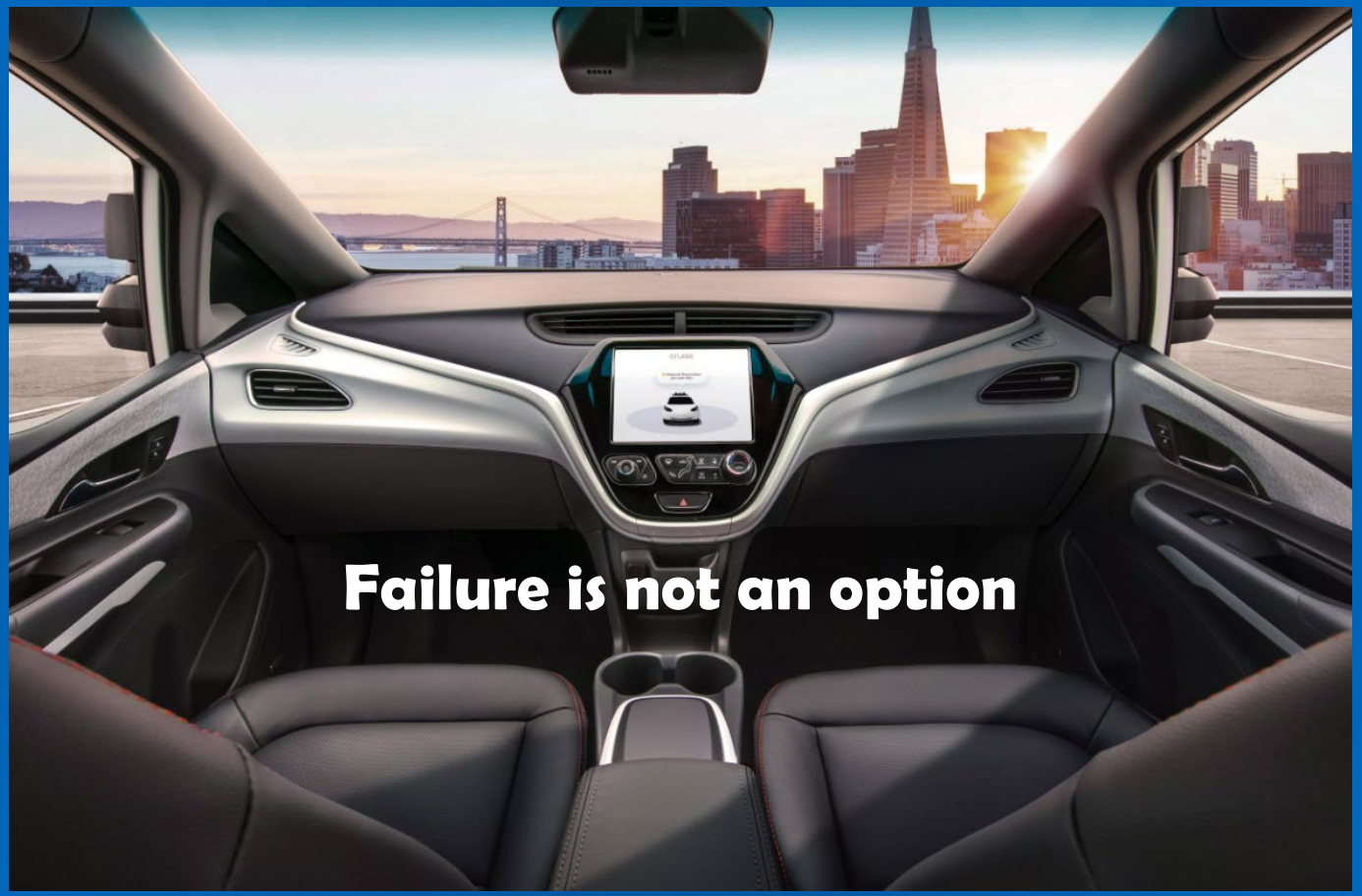


Electronics in vehicles - Now



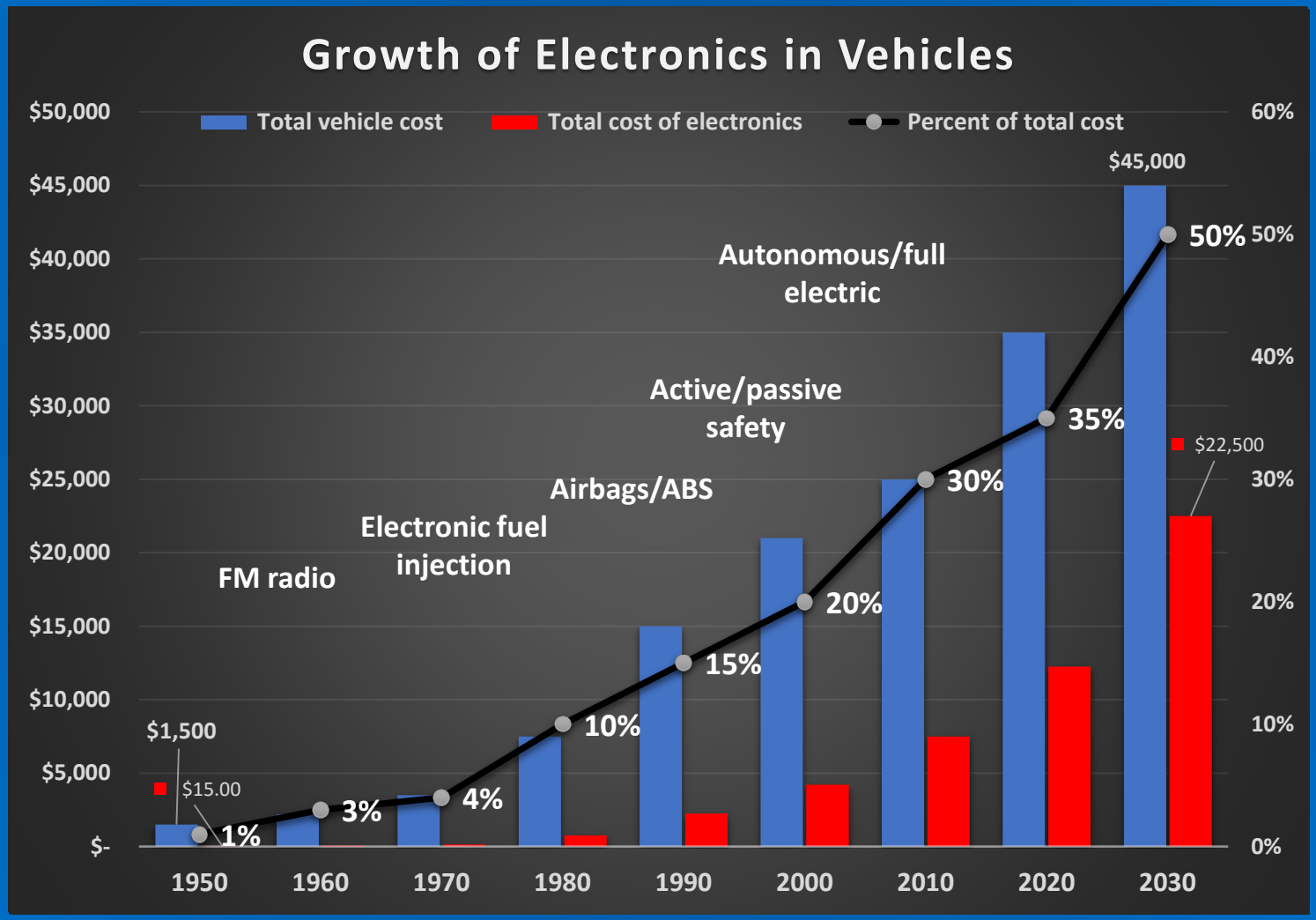
Current electronics on passenger automobile

Electronics in vehicles - Tomorrow



Level 5 Fully Autonomous Vehicle

Electronics in vehicles



Chemistry & Expertise for Manufacturing's Toughest Problems.

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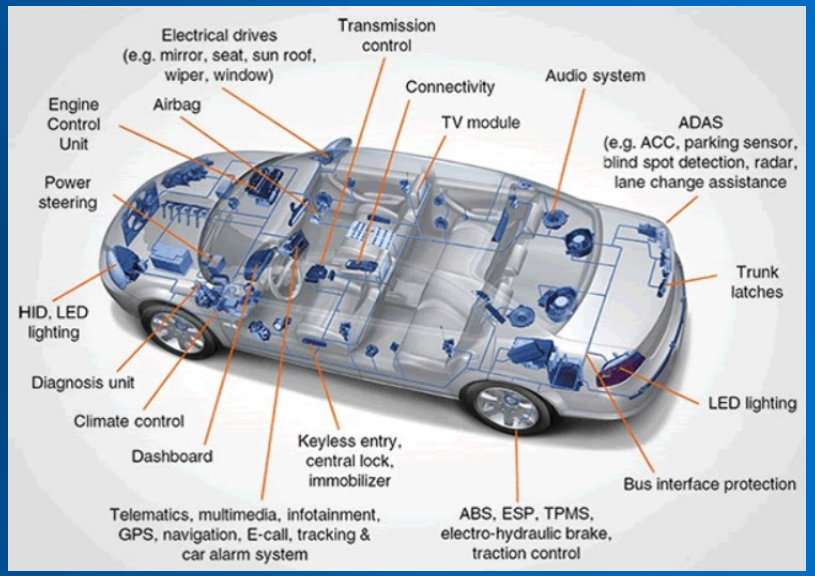
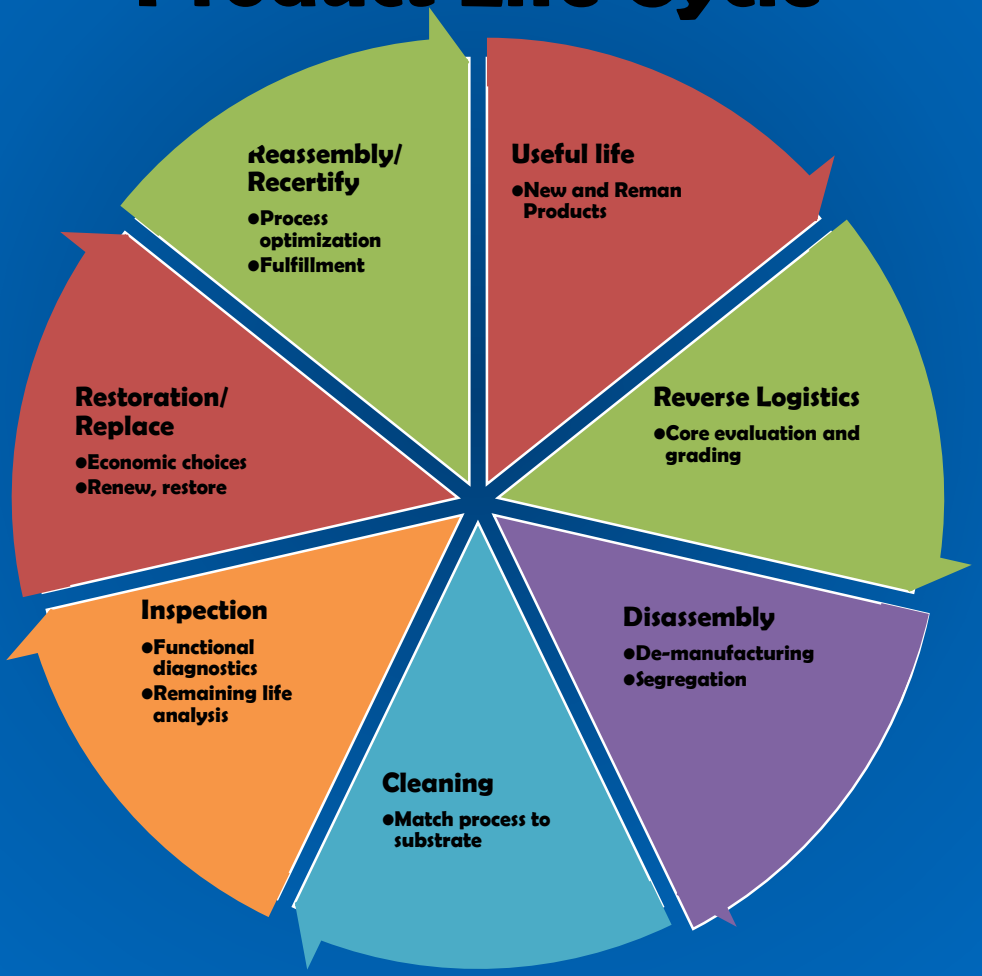
Critical Cleaning – extends into automotive

- Lighter, stronger substrates
- Exotic alloys
- Alphabet soup of plastics
- Other non-metallic surfaces
- New vocabulary for cleaning
  - Surface tension
  - Wetting agents
  - Specific gravity
  - Solubility
  - Vapor density/vapor pressure
  - Kb value



Automotive Electronics Remanufacturing Product Life Cycle



Automotive Electronics Remanufacturing Product Life Cycle

Cleaning

- Match process to substrate
- What is the material made of?
- What process is optimal?
- Choices
  - Aqueous
  - Solvent
  - Semi-Aqueous
- Equipment
- What is the next process?

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Failure Is Not an Option

Cleanliness is #1 for several remanufacturing industries:

- Automotive
- Aerospace
- Electronics
- Military

Identify the level of cleaning required

- **Class 1 = disposable electronics**

Identify the level of cleaning required

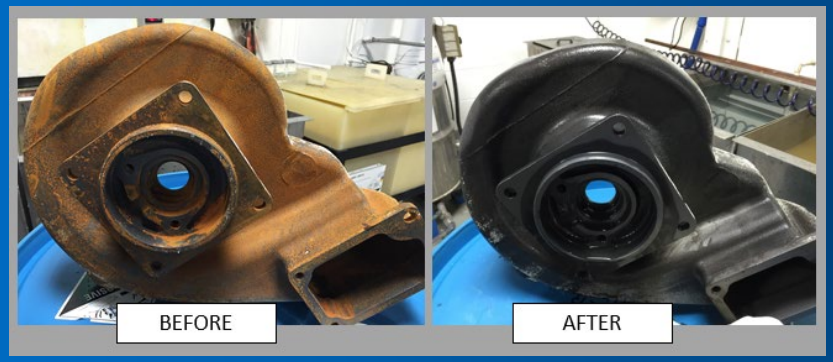
- **Class 2 = cell phones**

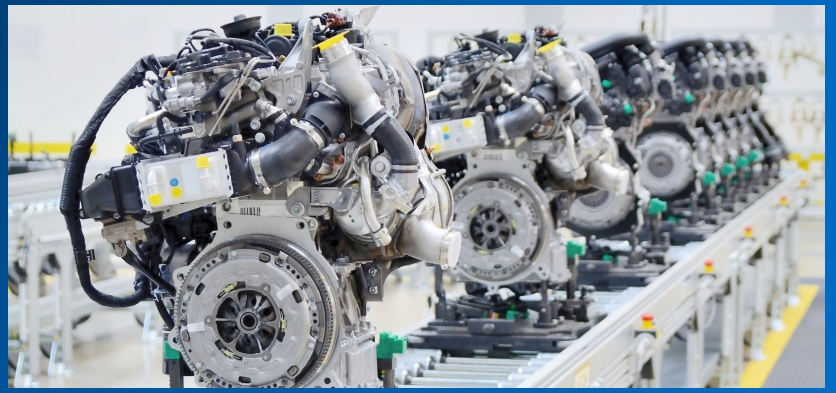
Identify the level of cleaning required

- **Class 3 = critical cleaning – think lidar for autonomous vehicle – cost of mistake is unacceptable**

It's all about the core

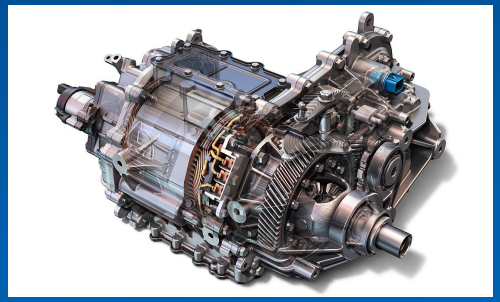
Traditional core restoration typically involves large, heavy parts without exotic metal alloys or sensitive components and delicate plastics

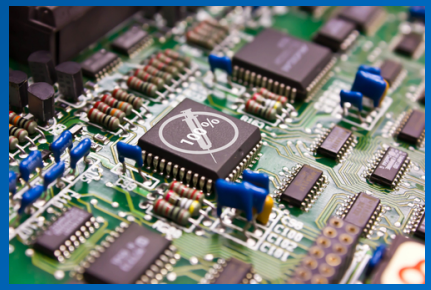




Identify the Part

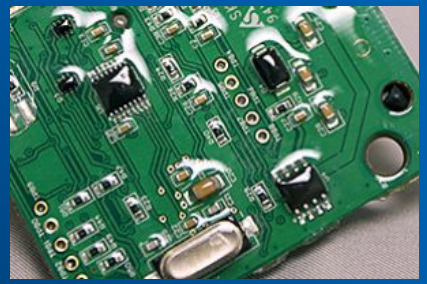
- Configuration
- Size
- Weight
- Blind Holes

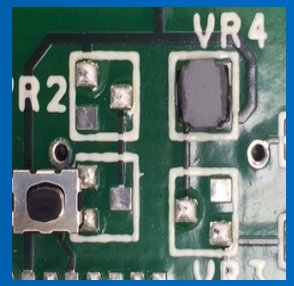


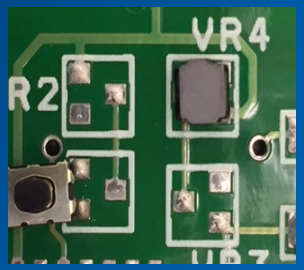


Identify the contamination

- Soils – there are only 3 types
  - Organic –
    - Lubricants and grease
    - Organic coatings/CARC coatings
    - Dissolved conformal coating
  - Inorganic –
    - Heat scale
    - “white” residue
    - Rust/Corrosion
    - Oxidized solder paste/flux
  - Particulate
    - Non-ionic
    - Powder coating

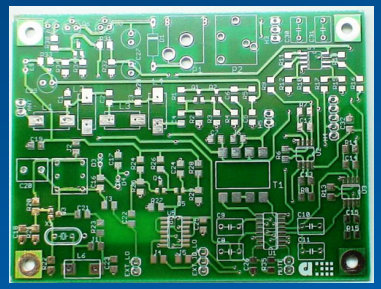


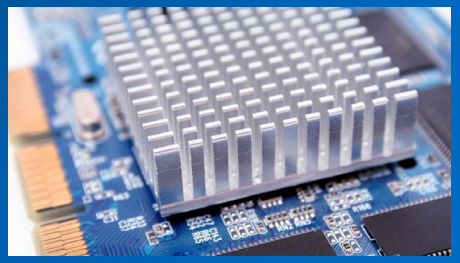




Identify the Substrate

- Carbon steel
- Stainless steel
- Aluminum-alloy
- Copper alloys
- White metals
- Non-metallic-plastic
- Fiberglass & epoxy
- Hard surface





Cleaning Chemistries

- **Solvents for Vapor Degreasing**
  - **HFC - Hydrofluorocarbons**
  - **Chlorinated (MeCl, TCE, PCE)**
  - **Brominated (nPB)**
  - **Hydrofluoroethers**

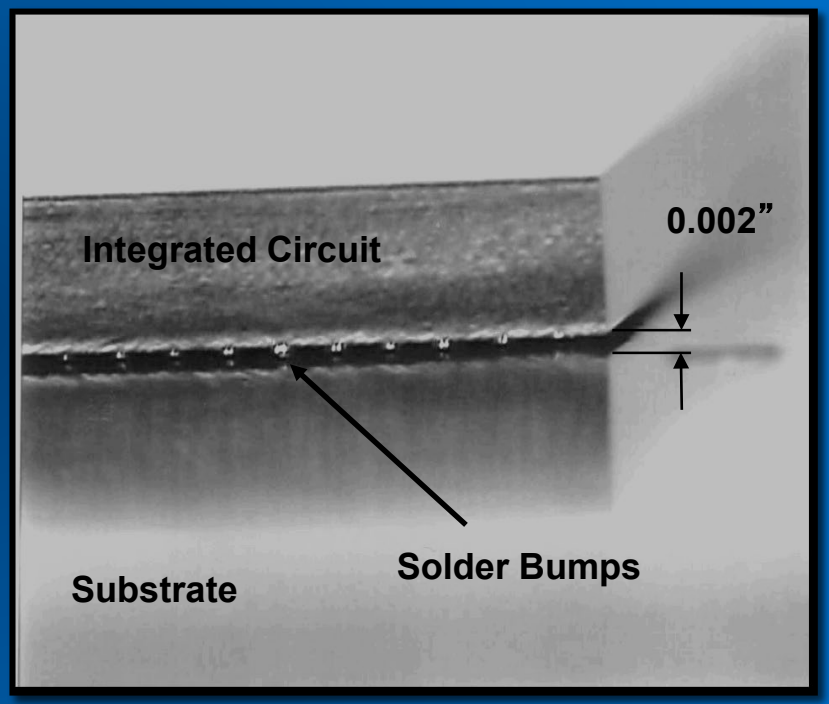
- **Alternatives to Solvent Vapor Degreasing**
  - **Hydrocarbons – Mineral spirits, ethanol, isopropanol**
  - **Semi-aqueous – water, terpenes, glycols**
  - **Aqueous – water, surfactants, additives**

Degreasing

- In aerospace and automotive electronics, Size and Weight Are Constrained, Leading to Very Small Parts With Tight Spacings
- Aqueous Systems Fail to Reliably Clean in Tight Spacings; Water Removal Also Is Problematic
- Vapor Degreasing Delivers Quality Cleaning in Minutes

Flux Removal

- Advanced Chips Generate High Temps
- Clearances Are Extremely Small
- Solder Joints Trap Residues and May Add "Noise" on a Circuit and/or Interfere With Under-filling of Epoxies
- Vapor Defluxing with Low-Surface Tension Solvents Eliminates the Problems



Particulate Removal

- Metal finings and dust particles can be trapped on small surfaces
- High density and low surface tension fluids remove particulates
- Vapor Degreasing Provides High Through-Put, Few Cleaning Errors

Identify Equipment Needs

- In-process considerations
- Segregate incompatible substrates
- Space concerns
- Environmental/ Regulatory concerns

Sustainability of Cleaning Process

Task	solvent degreaser (kWh)	aqueous degreaser (kWh)
deionize & heat water	0	1
operate degreaser	4	8
drying	0	5
wastewater treatment	0	4
total electrical use/hr	4	18
total electrical use/month	640	2880
stand-by electrical use/day	16	48
stand-by electrical use/month	512	1536
Total process electrical use/month	1152	4416

Sustainability of Cleaning Process

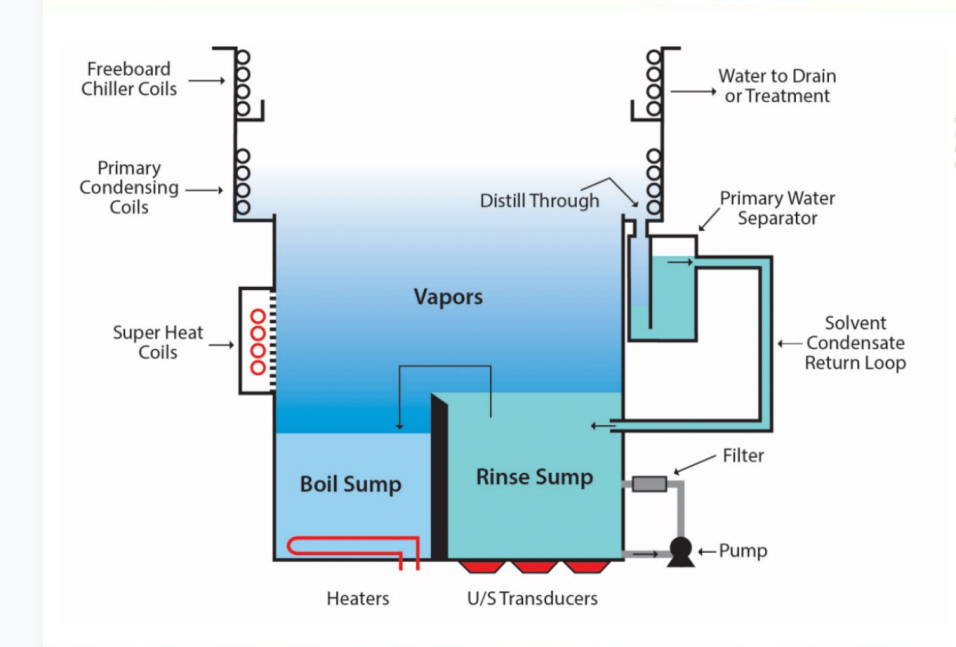
Chemical	Surface Tension	Viscosity, cP	Specific Gravity	Latin Heat, cal/g	Flash pt	Solvency (KB)
Water	72.80	1.00	1.00	543.00	N/A	6.50
Acetone	25.20	0.31	0.78	123.80	-20.00	6.50
Isopropyl Alcohol	22.10	1.06	0.81	167.70	53.60	N/A
TCE	26.40	0.79	1.46	56.40	N/A	129.00
nPB	25.90	0.49	1.35	58.80	N/A	125.00
HFE	14.00	0.67	1.52	30.00	N/A	10.00
HFC Blend	18.80	0.47	1.34	85.00	N/A	50.00

Why Choose Vapor?

- **Solvent Advantages:**
  - **High Cleaning Efficiency**
  - **Non-flammable**
  - **Quick Drying**
  - **Small Equipment Footprint**
  - **Lower Operating Cost**
  - **Self-cleaning**
- **Solvent Disadvantages:**
  - **Regulations**
  - **"First Fill" Costs**

Why Choose Vapor?

- Basic degreaser
  - 2 sumps
  - Boil sump
  - Rinse/ultrasonic sump
  - Vapors clean cold parts
  - Vapor condenses on cooling coils
  - Liquid collects and replenish the rinse sump



Cleaning Choices

Water	Hydrocarbon solvents	Fluorinated Solvents	Chlorinated Solvents
Inexpensive	Inexpensive	Expensive	Inexpensive
Readily available	Aggressive cleaning	Mild/aggressive cleaning	Aggressive cleaning
Safe	Fast drying	Fast drying	Fast drying
Wastewater treatment required	Special equipment needed	Drop-in most machines	Works in all degreasers, some mod.
Drying required	Flammable	cool-to-touch	Non-flammable
Large footprint	VOC's	Non-flammable	Hazardous
Energy consumer		Non-hazardous	Regulated

Thank you

Questions?

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