The Care and Preservation of
Electronics and its Circuit Systems
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INTRODUCTION

Electronics are classified as a type of object that contains a circuit system that controls the flow of electricity (electrons). These systems receive power from an outlet or a battery as such, maintaining functionality is a significant factor during preservation. These objects are increasingly becoming part of museum collections.

The information in this fact sheet has been compiled to assist in promoting the care of electronics and its circuit system. Proper handling is the first step in care of functional electronics which can be sensitive to static electricity forces. Additional measures include the identification of damage and the use of proper techniques for storage, and cleaning.

Note: Electronics are composite objects that are comprised of varied materials including: metals, rubbers, plastics, glass, and painted surfaces. For care and preservation of those specific materials, please look at our other fact sheets. This document focuses on the care of the circuit system.

Identifying Circuit Systems

Typical circuit boards consist of breadboard, stripboards, or printed circuit boards that serve as the foundation for capacitors, resistors, transistors, switches, inductors, and diodes. Below is a summary of common circuit board types:

Breadboards are a solderless gridded circuit board. The grid is normally an Acrylonitrile butadiene styrene (ABS) plastic lattice that protects plated metal clips for installed components. These boards are typically used to design a circuit in which components can be pushed in.

Stripboards are normally brown in color and made from a phenolic or fiberglass laminate board material. These boards are cladded by strips of copper in one direction. The components are soldered together.

Printed Circuit Boards (PCB) consist of an insulating layer (commonly fiberglass) that is sandwiched by two layers of copper circuitry and an epoxy layer. The copper is protected by a hot air solder surface leveling finish. There are several types of finishes: lead free solder, organic solder ability preservative, immersion metal (silver, tin, gold.), or hard gold. PCBs can take on several layers, depending on its specification and the components are affixed by soldering.

HANDLING

Careful handling is imperative! Attention must be given to the electrostatic sensitivity of electronics. The least amount of contact between the handler and object is recommended. Trays that have been lined with antistatic Inert Foams (DOW AS Ethafoam) should be to store and handle the electronics. When it is necessary to handle the circuit systems, actions should be taken to dispel the static charge from the handler prior to handling. A ground bracelet, grounding mat, or electrostatic discharge (ESD) certified apparel should be used for interaction. Electrostatic forces can be dissipated by touching a conductive metal prior to touching the circuit systems.

For enclosed and sealed electronics, general collections handling can be carried out using gloves to prevent fingerprint impressions from being left on susceptible surfaces.

Oversized Electronics with Multiple Parts

Electronics and computing devices range in size from handheld devices to oversize computers and servers. Larger objects may require a movement strategy, a team, and a conservator to document the condition of the electronic prior to its relocation. Some objects may require disassembly and reassembly of components to avoid damage.

TYPES OF DAMAGE

Corrosion, component damage, inherent damage from construction, and physical damage are the main types of disfigurement that can be found on circuit systems.

Corrosion

Corrosion can occur on exposed copper circuitry due to flaws in its construction or its exposure to a corrosive environment. For electronics made by flux soldering, it is important to inspect for residual flux on the soldered areas. The residues are hygroscopic (absorb moisture) which could promote corrosion. The invading moisture can affect the copper in circuit boards.

If dendritic crystals are visible, they may indicate the presence of problematic corrosion that should be addressed by a specialist conservator.

Bloated Electrolytic Capacitors

Capacitors are cylindrical shaped components that should be examined for bloating or swelling caps that indicate damage caused by the breakdown of a water-based electrolyte and a rise of hydrogen gas. This problem can lead to a failure of the cylinder construction from a build-up of pressure.

Burnt Resistors

Resistors consist of an internal metal film and ceramic core that is surrounded by two end caps. It is coated with several layers of epoxy. If burn marks are visible on the resistors, avoid operation of the electronic until these have been replaced.

Power Cords

Some power cords are hardwired, others have a removable female connection. The jacket on some cords can be constructed of rubber, textiles, or plastic. Rubber jackets tend to stiffen and break apart as they age exposing bare wire. Depending on their historical significance design of the cord and the electronic object, its preservation should be considered in consultation with a conservator.

Some power cord materials have a braided textile or rubber composite textile jacket, these types of cords are prone to fraying or rubber disintegration. A conservator should be contacted for advice or assistance in preserving these materials.

STORAGE

Composite Components

The temperature and relative humidity (RH) in which electronic items are stored and displayed is an important part of preservation efforts. A minimally fluctuating relative humidity of around 50% RH is ideal. Rapidly fluctuating temperatures can cause different materials stress from expansion and contraction. High humidity can swell certain hydrophilic materials, while low humidity can shrink hydrated materials. High humidity also promotes an environment where corrosion can flourish.

Battery Removal

Batteries left in portable electronics, can cause damage thus it is recommended that they be removed and stored separate from the object.

Batteries can cause electrochemical corrosion that can spread into the vulnerable circuitry. The table below summarizes common battery types and the issues related to their storage and degradation.

Common Electrochemical Battery Types	Associated Risk and Damage
Alkaline Batteries (Zinc and manganese dioxide base)	Leakage of potassium hydroxide that can react with CO_2 and promote corrosion towards a circuit system
Nickel Metal Hydride (NiMH)	Bloated battery with a buildup of hydrogen gas from failure
Nickel-Cadmium batteries	Cadmium is a carcinogenic hazard
Lithium-Ion batteries	Electrolytes in the battery are flammable.
Lithium Iron Phosphate ($LiPO_4$)	Safest of the battery types and should still be disconnected and separated for storage.

Battery disposal regulations should be taken in consideration. Modern electronics sometimes use custom sized internal Lithium-Ion battery “pouch cells” whose removal may require minor disassembly. Any invasive and complex disassembly should be carried out by a trained professional. The manufacturers may be able to aid in the process.

Keep in mind that the choice to remove custom “pouch cells” could prevent future operation of the device unless the same type of cell can be purchased. It is important to document the make, model, dimensions, voltage, and amperage of the batteries. This information can often be found printed on the cell or from the manufacturer. Specialty fire safe bags for storing Lithium-Ion batteries and other flammable batteries are available but for safety purposes they should not be stored in a museum collection storage area.

Circuitry Boards

For circuit boards that have been placed on antistatic foam trays, a dust cover constructed of blue board can be fabricated to fit the dimensions of the storage tray.

Antistatic or static shielding bags are another option for protecting sensitive circuitry in storage from dust and dirt. Silica gel desiccant packets should be placed inside sealed packing to absorb residual moisture.

CONSERVATION TREATMENT STEPS

Dust removal and cleaning of the circuitry will not be required if the electronic is stored in a dust-free sealed enclosure. If stored in an unsealed environment, dust can enter through fans and vents necessitating the removal of dust prior to operation. Accumulated dust interferes with operation the circuit system by interfering with heat dissipating components leading to overheating.

The following is a method for cleaning electronic circuitry: Make sure that the object is not plugged in or powered by a battery during the cleaning process.

Dry cleaning – This process makes the most difference when cleaning electronic circuits. Dust and dirt are often layered and accumulated on surfaces that can easily be removed.

- If the electrical components are being preserved, consider using brushes that are anti-static or Electrostatic Discharge (ESD) certified with the addition a ground bracelet or grounding mat.

- Canned air, an air bulb, or a portable compressor (with a water trap) are useful for dislodging dirt and dust. A canister vacuum with micro attachment should be used with the air devices to contain the debris. Soft brushes can also be used to agitate and reach any recessed areas, then picked up by a vacuum.
- Personal Protection Equipment (PPE) such a dust mask and safety glasses are recommended.

Wet Cleaning – can be used if dry cleaning is not sufficient. Volatile solvents are recommended as they evaporate quickly. It is important to look at the Safety Data Sheets (SDS), use Personal Protective Equipment (PPE), and have adequate ventilation when using solvents.

99% Isopropyl Alcohol is recommended. It should be applied with a small brush and worked into the components. Dirt from brushes can be transferred to Low lint woven absorbent materials; Kimberly-Clark Kim wipes, Kimtech Science brand wipes and Hollytex during the cleaning process. Cotton and unwoven cottons should be avoided as they can leave behind fibers that would need require additional work to remove.

Alcohol can also be used for removing flux residues using disposable flux brushes.

A well-sealed modern electronic should not require cleaning of internal components. Careful consideration should be given before attempting cleaning internal components as improper disassembly and cleaning can cause irreversible damage.

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Preparation, Art Handling, Collections Care Information Network (PACCIN)
http://www.paccin.org/

Find a Conservator

The American Institute for Conservation
https://www.culturalheritage.org/about-conservation/find-a-conservator

SUPPLIERS

Talas
New York, NY 10012
212-219-0770
https://www.talasonline.com/
Hollytex

World Wide Foams
https://worldwidefoam.com/
Antistatic ethafoams, ESD ethaf

Eastwood Company
https://www.eastwood.com/
Autosol Metal Polish

Digi-Key
https://www.digikey.com/
ESD, antistatic tools

iFixit
San Luis Obispo, CA
http://www.ifixit.com/
Small Tools and resources for disassembling

Local Hardware Stores and Hydroponics Stores
Local Pharmacy and Drug Supply Stores
99% Isopropyl Alcohol (Rubbing Alcohol), Acetone

Art Supply Store
Small soft bristle paint brushes

Note: The in-house conservation staff at The Henry Ford has developed these Preservation Fact Sheets to assist in caring for your historical materials. These fact sheets provide basic information on the care, cleaning, and handling of a particular type of artifact, referral information to other conservation organizations, and a bibliography of authoritative works. Individuals may also arrange for a private consultation with a conservator. For more information, please contact the Benson Ford Research Center at research.center@thehenryford.com.

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