The Dirt on Dirt: Best Practices for Cleaning Zebra Mobile Computers

Overview

Mobile computers are designed and built to withstand harsh environmental conditions, making them the right tools for jobs in less forgiving physical environments. Unfortunately, due to these rugged environments, the risk of damage due to environmental contamination may also be increased.

One may think of contamination to be solely a cosmetic issue, but over time these contaminants can cause a severe degradation to the mechanical integrity of a device and significantly reduce its working life. Fortunately, this damage can be mitigated through routine and healthy cleaning practices.

This document explores the importance of device cleanliness and maintenance, as well as providing best cleaning practices for prolonging the life of your mobile computer.

Working Theory: Why Clean?

Rugged environments introduce contaminants and chemicals that may cause damage, which can be broken up into two general categories — physical wear and corrosive wear.

Physical Wear and Contaminants

Physical wear is the deformation and/or removal of material from a surface as a result of physical contact. The most common mechanism of physical wear encountered by mobile computers is abrasion — in particular, “three-body abrasion.” As the name suggests, three-body abrasion involves two contact surfaces and one abrading element.

In the case of a mobile computer, one contact surface is an exterior surface of a device and the other is a user’s hand or surface on which the terminal rests. Any type of environmental contamination acts as the abrading element. The abrading element is located between the two contact surfaces, as illustrated in Figure 1.

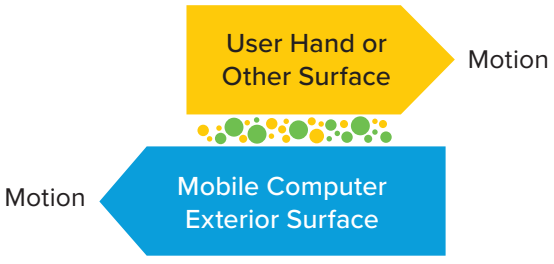

Figure 1: Three-Body Abrasion

Relative motion between the contact surfaces causes the contaminants to chip away at the exterior of the mobile computer, and eventually create micro-abrasions. If contaminants are not removed promptly, the micro-abrasions will become larger in appearance and rough in texture.

Abrasion presents itself on transparent surfaces as scuff marks, and can make reading a mobile computer screen very difficult for the user or barcode reading nearly impossible for a scan engine. The effects of abrasion on transparent surfaces, such as scanner windows and touch panels, are not reversible by simple means and usually require sending the mobile computer for repair to regain display or scanning functionality.

Aside from creating unsightly scuff marks, which may inhibit function, a contaminated surface will also continue to collect contaminants by providing a compliant surface for the contaminants to stick to, as opposed to a clean surface from which the contaminants might simply slide off.

Figure 2: Recontaminated Surface

Figure 2 depicts the initial contamination of an exterior surface in green, and additional contamination adhered to the initial contamination, shown in yellow.

This effect is significant for two reasons — the mobile computer takes on a dirty appearance and the grooves created by the contaminants allow environmental chemicals to start accumulating within them. Both conditions are catalysts for corrosive wear.

Chemical Reactions and Corrosive Wear

Corrosive wear is the degradation of a material as a result of a chemical reaction. It is important to understand:

- The mechanism behind corrosive wear
- The chemicals that can cause corrosion
- Where the chemicals are found

Typically, strong acidic or basic chemicals cause the most corrosion since they contain more ions than neutral chemicals, such as water, and the ions attempt to react with the surface material in order to reach a stable and balanced state. The reaction almost always results in degradation of the external surface.

Contrary to popular belief, corrosive chemicals are not only found in the laboratory. Many household cleaners, and even bodily fluids, are mildly corrosive. These chemicals include sweat, mild detergents, soaps, household cleaners, hand sanitizer, hand lotions, and personal care products.

While it is inevitable that these corrosive chemicals will at some point come in contact with a mobile computer, mobile computers are built from corrosive-resistant materials. Under normal use conditions, corrosive wear will not typically present itself as a problem; however, corrosive-resistant materials are not corrosive-proof, but instead corrode at a significantly slower rate than other materials.

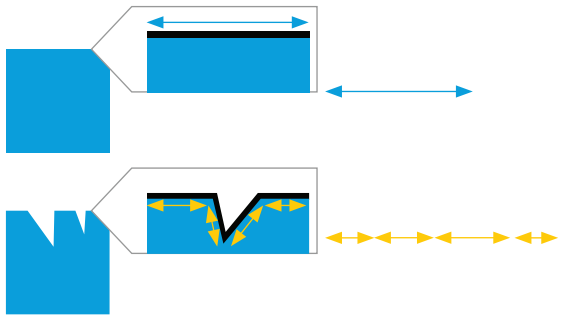

Figure 3: Increased Surface Exposure to Corrosive Chemical

Figure 3 depicts several conditions that should be avoided to slow corrosion.

Increased Working Exposure to Corrosive Material

The longer a corrosive chemical is allowed to act on a surface, the more corrosion it will produce.

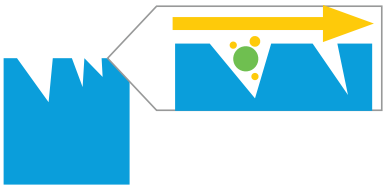

Figure 4: Increased Working Exposure to Corrosive Chemical

Once captured within the micro-abrasions, the chemical is shielded from any external interactions that would act to remove the chemical (such as wiping the unit down) by recessing the chemical into the external surface wall, as illustrated in Figure 4.

This allows the chemical to remain within the micro-abrasions for extended periods of time, and act on the external surface to produce corrosion.

Once the corrosive chemical has migrated into the micro-abrasions, it will attempt to penetrate deeper into the external surface.

Consider waste water flowing through a rusted pipe. The rust creates micro-abrasions in which the waste takes residence, and acts to corrode the metal pipe further. The pipe will corrode until, eventually, a hole develops.

Best Cleaning Practices

If a surface becomes contaminated and the contaminants are not removed, the surface may become more susceptible to breaking under normal use case conditions. This is when the user may notice cracked touch panels after a drop, scratches, or components falling off.

Fortunately, this susceptibility to breaking can be prevented with good, proactive cleaning practices. Following is a list of general best practices to use when cleaning your mobile computer.

Clean Lightly, But Often

- Extended time in between cleanings can lead to a buildup of heavy contamination, and the user may be tempted to apply excessive force to remove the contamination.
- Excessive removal force will work to separate the contamination from the external surface, but may also result in physical wear of the external surface through three-body abrasion.
- Frequent cleaning does not allow the buildup of multiple layers of contamination and requires significantly less effort to remove.
- Most cleaners contain solvents, which can attack adhesives. As a result, special attention must be paid to cleaning agent application instructions.

Use a Clean, Lint-Free Cloth

- Be sure to use a clean lint-free cloth when cleaning your mobile computer. Lint is considered a contaminant and wiping lint around the surface of a mobile computer is the textbook definition of three-body abrasion.
- Cleaning rags with rough fibers or prior contamination will produce an abraded surface and can lead to further contamination and degradation.

Remove Loose Contaminants First

- Use compressed air or a soft cloth to remove large, loose contaminants first.
- Cleaner should be used to remove stuck-on debris, not debris that can readily come off.

Wipe Off Cleaner as Directed

- Wipe off cleaner as directed by cleaning instructions.
- Most cleaners are engineered to evaporate when cleaning is complete, but others require the user to wipe the cleaner off manually.
- Longer soak time does not necessarily mean a cleaner surface, but instead may result in degradation of the surface or migration into the product or sealing features.

Apply Cleaner to the Lint-Free Cloth, Not Your Product

- Avoid longer surface exposure time
  - Many cleaning products are also classified as mild solvents. Although this is a necessary property of cleaning agents, cleaning products are designed to remain on the contaminated surface for a short time to prevent excess exposure.
  - Problems occur when a cleaning product remains on the external surface for longer periods of time than intended.
- Localize cleaning product application
  - Applying cleaner directly to the external surface makes localizing application difficult. The cleaner can more easily find its way into micro-abrasions to take a more permanent residence.
  - Localization is especially important when specific surfaces are sensitive to certain chemicals and should not be in contact with them. This can be avoided by applying the cleaner to a cloth first and not directly on the computer.

Do Not Clean Cracked or Damaged Products

- Do not clean a cracked or damaged mobile computer; send it for repair immediately.
- Applying cleaning agents to an already damaged product allows the chemical to set up camp in previously existing cracks and can make cracks worse as the cleaning agent acts on a now larger surface area.
- A cracked or broken product poses a serious safety threat to those who use them due to the sharp corners that can be generated.

Critical Cleaning Areas

Many different types of surfaces exist on a mobile computer, including:

- Transparent surfaces
- Electrical contacts
- Latches/moving parts
- Crevices/keys/triggers
- Labels
- Adhered components

Each one of these surfaces requires special attention when cleaning. The following are some best practices for removing contaminants from these critical cleaning areas.

Transparent Surfaces

- Use compressed air first to remove all loose contaminants.
- Alcohol-based glass cleaner or isopropyl alcohol of 70% concentration or higher is preferred for use on transparent surfaces, as this type of cleaner will dry quickly and streak free. A standard lint-free soft fiber cloth should be used. Apply cleaner onto the cloth and apply to glass in small circular motions until dry.

Electrical Contacts

- Use compressed air first to remove all loose contaminants.
- Isopropyl alcohol of 70% concentration or higher is recommended for this surface.
- Small-tipped cotton swabs may be used to scrub the contact surfaces and remove contaminants. Allow the isopropyl alcohol to evaporate.
- Keep in mind that electrical contacts contain a thin layer of gold plating, which is necessary to maintain electrical contact, but is also highly susceptible to physical wear; scrub lightly.
- Use a spiral motion when contacts are large enough to do so, starting on the inside and working the cotton swab to the outer bounds of the contact.

Latches/Moving Parts

- Use compressed air first to remove all loose contaminants.
- Do not use shop air as it may contain contaminants. Be sure to blow the compressed air into all parts of the latch, in both the latched and unlatched state. Blow air at a small angle to the surface.
- A cotton swab and isopropyl alcohol of concentration 70% or greater can be used as a cleaner.

Crevices, Keys and Triggers

- Use compressed air first to remove all loose contaminants.
- Be sure to blow the compressed air into all parts of a key (in both pressed and released states), crevice, or trigger.
- A cotton swab and isopropyl alcohol of concentration 70% or greater can be used as a cleaner.

Labels

- Use compressed air first to remove all loose contaminants.
- Labels are typically made of more permeable materials than other components, such as housings or glass touch panels. As a result, a liquid cleaner should not be used. Instead, wipe clean with a lint-free cloth.

Adhered Components

Adhered components include anything glued onto the mobile computer, such as bumpers, gaskets, or branding plates.

- Use compressed air first to remove all loose contaminants.
- Read the provided cleaning documentation that came with your mobile computer to understand the cleaning agents that will damage the adhesives used, and refrain from using these agents.
- Typically, 70% or greater concentration isopropyl rubbing alcohol is safe to use on most adhered components.
- Wipe the cleaning agent from surface as directed by cleaning agent instructions.

Cleaning Agents Not To Use

- The following cleaning agents have been known to cause damage to mobile computers and should not be used to clean any surface of your device:
- Ammonia solutions
- Acetone (found in nail polish remover or paint thinner)
- Ketones
- Ethers
- Aromatic and chlorinated hydrocarbons
- Aqueous or alcoholic alkaline solutions
- Ethanolamine
- Toluene
- Trichloroethylene
- Benzene
- Carbolic acid
- PDI AF3
- Dipropylene glycol n-propyl ether-based chemicals

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Part number: WP-BPCMC 05/21/2020