AEROSPACE METALS, LLC

# The Anodizing Limitation

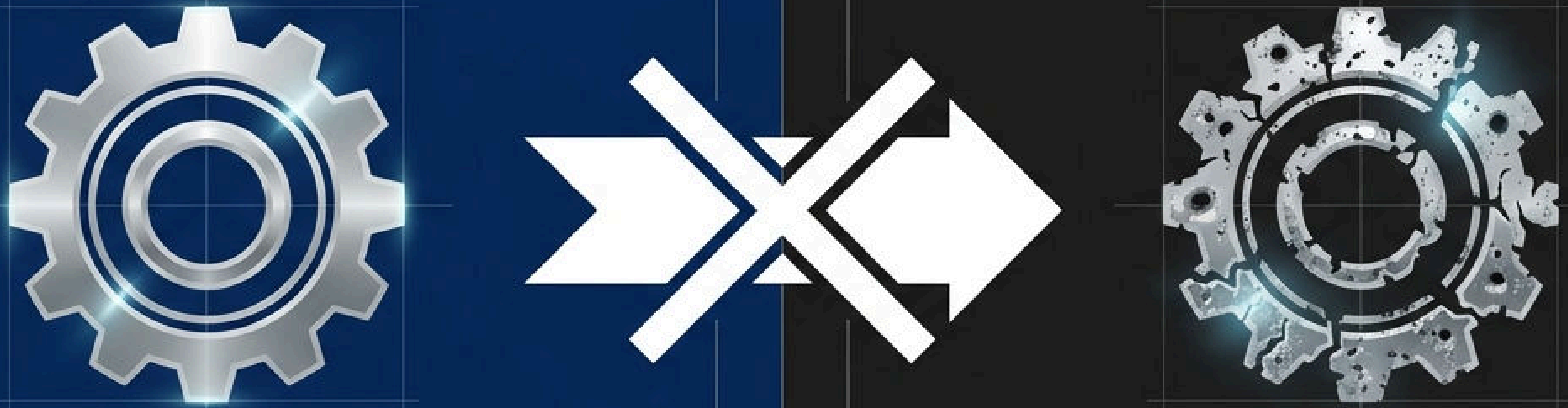
## Why Steel and Ferrous Alloys Require Different Finishing Solutions

Based on metallurgical analysis by Anna Otto.

# The Finishing Myth: Universal Anodizing

## The Cosmetic Expectation

## The Physical Reality



When seeking a durable, corrosion-resistant finish, many engineers and designers assume that anodizing can be applied universally to any metal part, including steel.

Anodizing is fundamentally driven by the unique properties of aluminum (and a few other non-ferrous metals)—not a universal coating process.

# The Microscopic Blueprint: Oxides in Action

## Aluminum

During the anodizing process, aluminum converts its surface into a highly ordered, porous aluminum oxide layer. This layer is tightly integrated with the base metal, highly durable, and readily acts like a sponge, absorbing dye for coloring.

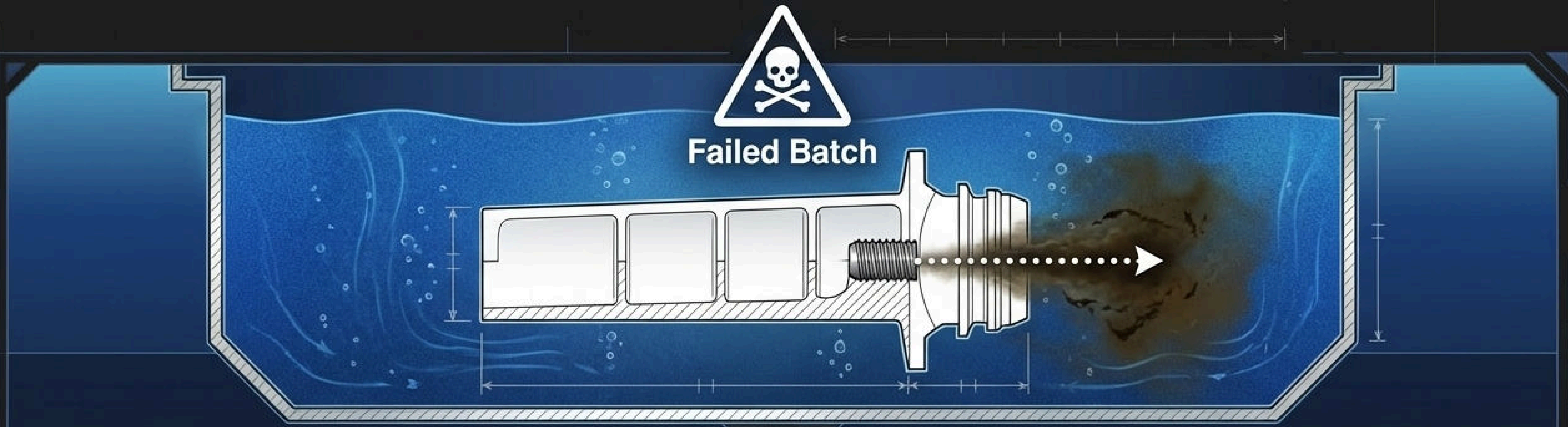


## Steel

(Iron-based alloys)

Steel does not form a stable, protective oxide layer. Instead, it forms iron oxide (rust). It is structurally weak, flakes away from the base metal, and accelerates further corrosion rather than preventing it.

# Secondary Drivers: The Electrochemical Trap



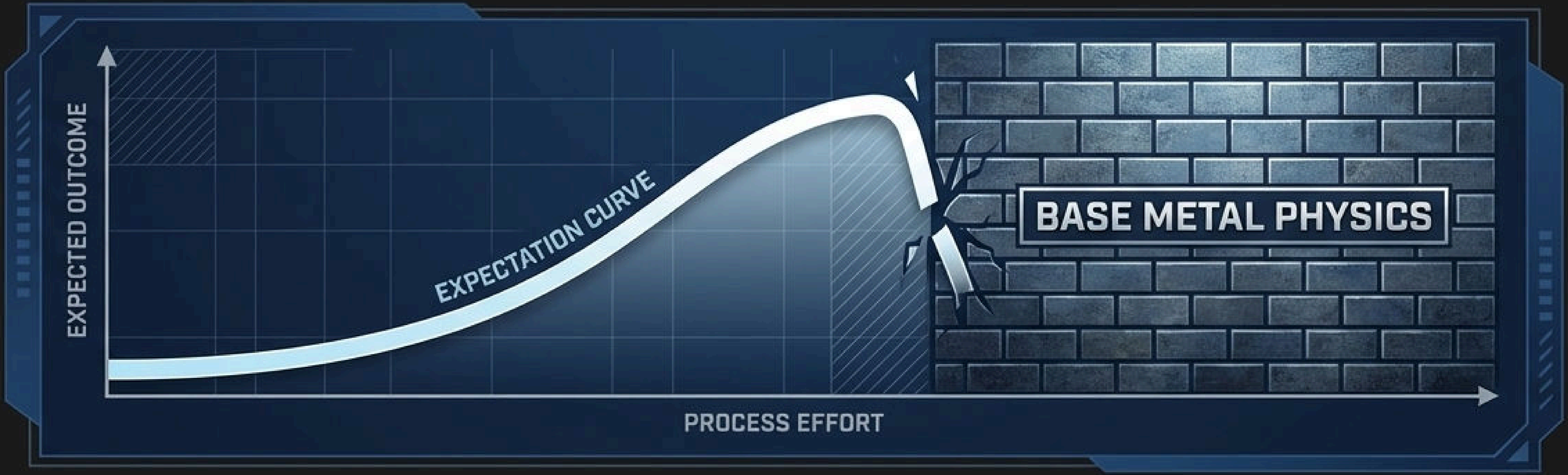

## The Bath Chemistry

The sulfuric acid or chromic acid baths used to anodize aluminum are highly corrosive to steel. Placing a steel or ferrous alloy part into an anodizing tank will simply dissolve or severely pit the metal, ruining the component.

## Contamination Risks

Even a small steel insert, helicoil, or pin left inside an aluminum part during anodizing will dissolve, potentially contaminating the entire chemical bath and ruining the finish on the aluminum itself.

# The Expectation Curve: Process Cannot Overwrite Physics


Processing plays a role, but even with flawless surface preparation, steel will never anodize. The process fundamentally relies on the ability of the base metal to form a stable, protective oxide—a physical reality that ferrous metals lack. To protect steel and ferrous alloys, completely different finishing protocols are required.

# Cosmetic vs. Functional Specification Matrix

Select your material and finish based on the ultimate requirement of the component.

| Criteria | Aluminum Alloys (e.g., 6061-T6) | Steel & Ferrous Alloys |
|---|---|---|
| Protective Oxide | Forms stable, hard aluminum oxide (Anodizing) ✓ | Forms unstable iron oxide (Rust) ⚠ |
| Primary Strengths | Lightweight, highly machinable, accepts dye (Type II) | High tensile strength, magnetic properties, impact resistance |
| Recommended Finish | Type II or Type III Anodizing, Chromate Conversion | Zinc-Nickel Plating, Electroless Nickel, Powder Coating |
| Recommended Application | Aerospace frames, cosmetic enclosures, lightweight tooling | Structural load-bearing components, high-wear shafts, fasteners |

# Processing Capabilities: The Alternatives for Steel

### For Corrosion Resistance

- Zinc or Zinc-Nickel Plating
- Cadmium Plating
- Electroless Nickel Plating

### For Wear Resistance

- Hard Chrome Plating
- Heavy Phosphate Coating

### For Cosmetics

- Powder Coating
- Black Oxide

**REQUIRED STEEL MITIGATIONS**

# Aligning Material Specifications with Intent

## 1. Acknowledge the Physics

Steel cannot be anodized. It forms unstable rust instead of a protective oxide layer. Set finishing expectations accordingly.

## 2. Evaluate Structural Need

If steel must be used for its high tensile strength, explicitly specify alternative protective finishes like zinc-nickel plating or electroless nickel.

## 3. Pivot for Cosmetics

If a dyed, anodized finish is a critical requirement for the part's appearance or function, abandon steel and specify an appropriate aluminum alloy.