EPI PEN JR. AUTO-INJECTOR

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INTRODUCTION
M3 product teardown process

Why do product teardowns?
Part of the product development process is to apply knowledge gained from prior experience during the concept development and design phases. Some experience comes from having directly designed something in the past and other experience is more indirect. It is this indirect product development experience that is gained from product teardowns. This process serves two purposes:

1. It forces the deconstruction team to carefully investigate the product pieces and learn as much as possible about the design details.
2. It provides a detailed record of the process for future reference by other product designers.

Teardowns are different from Reverse Engineering
Reverse engineering a product is nothing more than figuring out the design and manufacturing methods, typically for copying. M3 Design views product teardowns as ways to gain insight into the design to become better product developers. We focus on "Why" questions.

• Why did the designer make the choices they did?
• Why were certain construction techniques chosen?
• Why were some features included and others left out?
• Why was the design approach chosen?

This serves to gain more in depth understanding into the product's design rather than a superficial once-over.
INTRODUCTION

M3 product teardown process

How does M3 Design approach product teardowns?
The product teardown process is a rigorous approach to carefully catalog the deconstruction in both pictures and written descriptions. The overall approach is outlined below.

1. SELECT

When we come across products that claim to be unique, look complex, seem interesting, or no longer work, we want to know the “how” and “why” of the product’s design. We take apart products to learn valuable lessons from other product developers. By studying how products are designed, constructed, or failed, we expand our knowledge of design solutions.

2. DISSECT

We think critically about the products as we take them apart in order to deduce the design decisions of the original developers. By placing ourselves in their shoes, we expand our experience by imagining hypothetical design constraints to answer the “how and why” questions. In turn, we learn valuable lessons that we can later apply to our own product development process and share our findings with others.

3. UNDERSTAND

By answering the questions below, we can then apply the learning into future brainstorming, concept exploration, prototype development, detailed design, design for manufacturing (DFM), cost reduction analysis, and maintenance/troubleshooting.

- Why were specific materials or components chosen?
- How was the size and shape maintained?
- Why were certain construction or assembly techniques used?
- How were specific features or mechanisms executed?
PRODUCT TEARDOWN

EpiPen Jr. Auto-Injector
OVERVIEW

EpiPen Jr. Auto-Injector

One of the challenges in product design is creating products that are sophisticated yet work transparently in straightforward user scenarios. Achieving this is especially important in medical and military environments, where having to pause to read an instruction manual can mean the difference between life and death.

Recently, the M3 team disassembled a simple but intimidating product – an EpiPen Jr. Auto-Injector. It is used to quickly administer epinephrine to treat life-threatening allergic reactions (anaphylaxis). The powerful yet elegant internal mechanism certainly surprised the team.
EXTERNAL CONSTRUCTION

Construction Overview

The EpiPen is packaged in a clear plastic case with a flip-top lid. It contains a living hinge with an over-center beam that biases the lid into its fully opened position. This holds the lid out of the way in order to create an unobstructed path to slide the pen out of the case.

The exterior of the EpiPen itself has three distinct sections.
1. Instruction Label
2. Safety Shroud
3. Safety Cap
EXTERNAL CONSTRUCTION

Construction Overview

Inner mechanisms can be seen through the plastic Main Housing after removing the label.
- The orange Safety Shroud can slide back into the Main Housing.
- The white section on the left contains the Injection Mechanism.
- Fluid in a glass Syringe is visible through the open window.
EXTERNAL CONSTRUCTION

Disassembly

Because the spring mechanism shoots a needle that injects a chemical potentially causing arrhythmia and seizures, we made sure that only the most junior engineer disarmed the device (don't worry, we gave him safety glasses). We also took great care not to touch the Safety Shroud until we knew the EpiPen was safe to handle.

As the Main Housing of the product is a single plastic tube with no screws, the first challenge was discovering how to gain access to the internal system without removing the Safety Cap or activating the Injection Spring. This was achieved by drilling out the two sets of one-way snaps included in the design that were elegantly hidden behind the label.

Once removed, the internal assemblies freely slid out from the Main Housing.
SYSTEMS

Injection Mechanism Subassembly

When triggered, the Injection mechanism pushes epinephrine from the Syringe.

The Epinephrine Syringe and needle were removed to “disarm” the device.

4 parts make up the Injection Mechanism
2. Trigger Housing.
4. Epinephrine Syringe with Needle.
SYSTEMS

Syringe Driver Subassembly

The Syringe Driver Subassembly contains the stored energy in the system.

The collar on the Plunger Driver compresses the Injection Spring.

Snaps on rear of Plunger Driver lock into Spring Housing.

The snaps keep the Injection Spring compressed and ready to fire.
pressing the epiPin against the thigh with 3 lbs of force drives the syringe driver subassembly into the trigger housing.

chamfered edges inside the trigger housing compress the snaps on the plunger driver, releasing the syringe forward until the needle is fully exposed.

the injection spring continues to extend, expelling the fluid out the needle.

Post on the safety cap does not allow the snaps to deflect inward and release the mechanism. Acts as a safety mechanism for the device.
FIRING TEST
Safety Glasses Please!

The firing video speaks for itself.

https://www.youtube.com/watch?v=CxBTO0f r6Vk

Injection Spring fully loaded at 25lb. Easily enough to penetrate clothing and skin in an emergency!
SYSTEMS
Safety Shroud Mechanism Subsystem

Safety Shroud Mechanism conceals the needle immediately after use to prevent re-use or injury.
**SYSTEMS**

**Safety Shroud Mechanism Subsystem**

Syringe Stop housing holds the orange Safety Shroud via two Safety Snaps.

Shroud Spring is released by the Syringe pressing on the Safety Snaps inside the Syringe Stop Housing.

Deflecting the Safety Snaps uncouples the Syringe Stop Housing from the orange Safety Shroud. This allows the Safety Shroud to move forward and protect the needle.
SYSTEMS
Safety Shroud Mechanism Subsystem

Safety Snaps are separate parts instead of molded into the Syringe Stop Housing.
• Allows for a pivot motion about an internal pin. Pivoting helps parts not shear when deflected.
• Improves reliability by not relying on plastic flexures that may creep or stress relax over time.
SYSTEMS

Safety Shroud Mechanism Subsystem

When extended, Lockout Snap features on the Syringe Stop Housing pop out to lock the Safety Shroud in position.
User presses the orange tip against their body.
• Entire stack is compressed towards the Trigger Housing on the proximal end.
• Tapers press the snaps on the Plunger Driver which fires the Plunger Driver and Syringe forward.
• Plunger Driver continues forward and dispenses the medication.
• Safety Snaps holding the Safety Shroud are released by the Syringe.
• Pressure from user keeps the Shroud Spring compressed which keeps the Safety Shroud retracted.
• When pulled from the skin, the Safety Shroud locks into place protecting the needle.
CONCLUSIONS

Extremely simple device from the users perspective that upon further investigation has many complex internal mechanisms to create a reliable series of events. One input (pressure on the tip) creates two outputs (injection of medication and protection of the tip).

As a single-use medical device, the error-proof design intent is elegantly executed.
Product Teardowns