Product teardown

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Product Teardown

- The process of taking apart a product to understand how it is made and how it works

- A product teardown process is a formal approach to learning about and modeling the functional behavior and physical components of a product

Product Teardown

- Primary purposes
  - Dissection and analysis
  - Competitive benchmarking
  - Experience and knowledge

Dissection and Analysis

- Evaluate the current status of a product
- Understand the current technology, functions, and components
- Identify strengths, weaknesses, and opportunities for new products

Competitive Benchmarking

- Establish a baseline in terms of understanding and representation of the competition

- The baseline provides a comparison for new conceptual designs.

Experience and Knowledge

- Grow engineering knowledge from which to draw in new concept development

- Provide the basis for transferring solutions to analogous problems

Teardown Process (5-steps)

1. List the Design Issues
2. Prepare for Teardown
3. Examine Distribution and Installation
4. Disassemble, Measure, and Analyze
5. Create Data Sheets and Models

Step 1: List the Design Issues

- Identify the purpose of the teardown
- Determine what models should result from this process
- Create a data sheet in which all information can be captured

Step 1: Continued

- What are the problems and opportunities that the design team facing?
- New project
  - Not all design issues are known
  - Investigate the customer requirements and competitors products
- Re-design
  - What was difficult?
  - What problems were solved?
  - What are the related technologies?

Step 1: continued

- Customer needs
- Product functionality
- Information includes
  - Component names
  - Quantity of parts
  - Dimensions
  - Material
  - Weight
  - Manufacturing process
  - Primary functions
  - Cost

Step 2: Prepare for Teardown

- Gather tools that are needed for:

1. Disassembly
   - Screw drivers
2. Process Documentation
   - Camera
   - Video tape
   - Multi-meter
   - Flow meter

Step 3: Examine Distribution and Installation

- How to acquire parts?
- How to distribute and market the product?
- How is the product packaged?
- What is involved in installation?

- Examine consumer installation instructions and procedures for costs, effectiveness, and liability

Step 4: Disassemble, Measure, and Analyze

- Take pictures of the product
- Run, analyze and measure the product
- Coordinate disassembly with measurement, experimentation, and modeling
- Avoid destructive disassembly

Step 4: Continued

- Take apart the product
- Take pictures of each component and major assembly
- Take measurements to complete data sheet
- Be sure that all data models and pictures are referenced in the data sheet

Step 5: Create Data Sheets and Models

- Exploded View
  - Photos documenting product assembly
  - Geometric models

- Bill of Materials (BOM)
  - A written form detailing the product's components
  - The data collected in BOM are required for analyzes (including cost and performance)

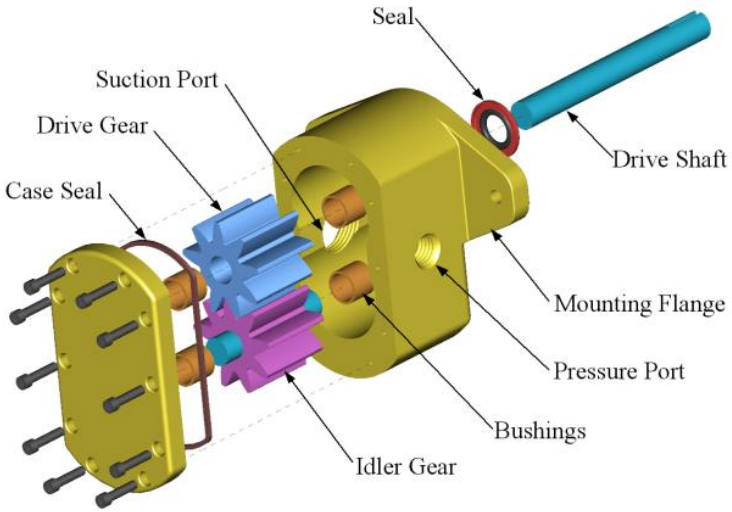
Step 5: Continued

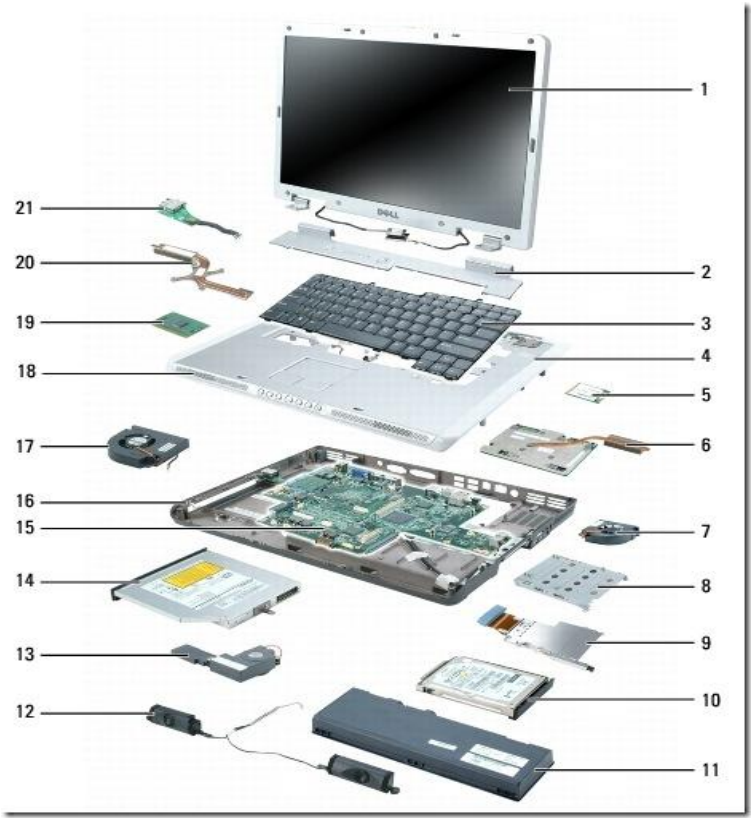
- Functional models
  - Focus on *what it does* not *how it does it*.
  - Demonstrate the product's transformation and of materials, information, and energy from an input state into the desired functions

- Force flow diagrams
  - Track the movement of forces through a product
  - Provide opportunities for component combinations to improve product

Exploded View

- An **exploded view drawing** is a diagram, picture or technical drawing of an object, that shows the relationship or order of assembly of various parts





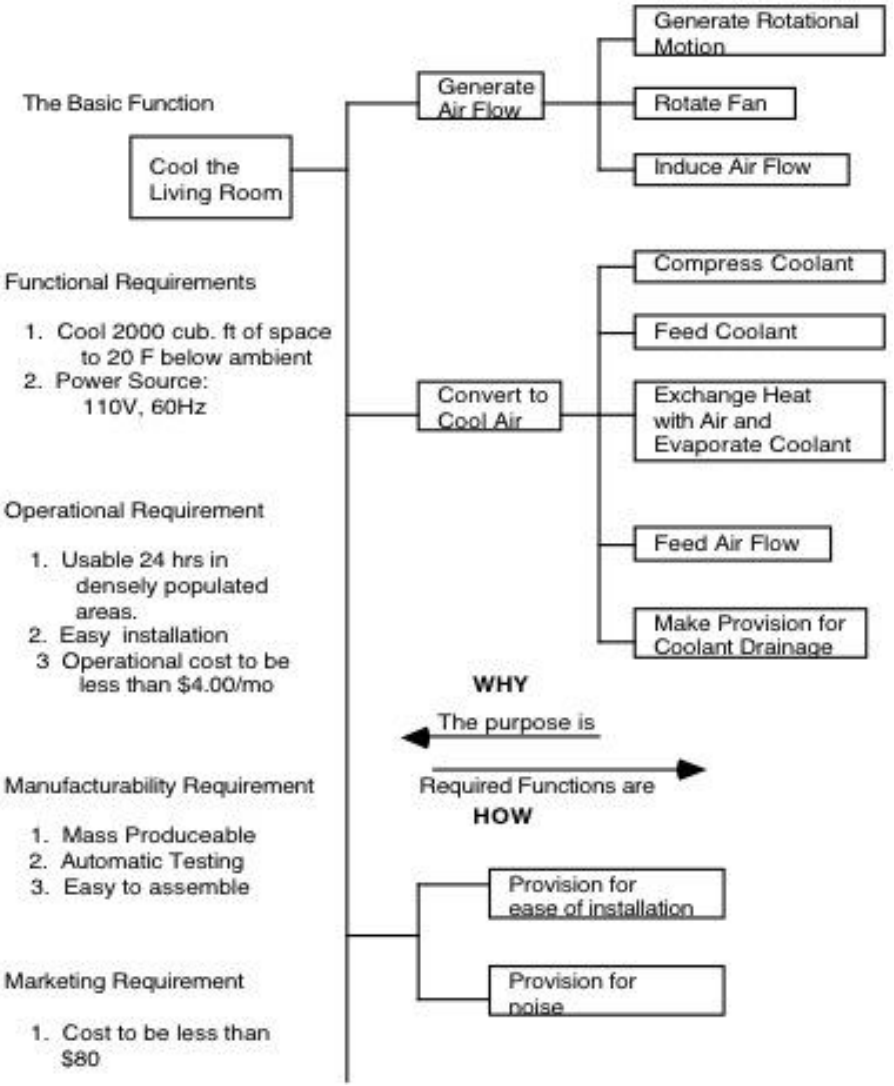
Bill of Materials (BOM)

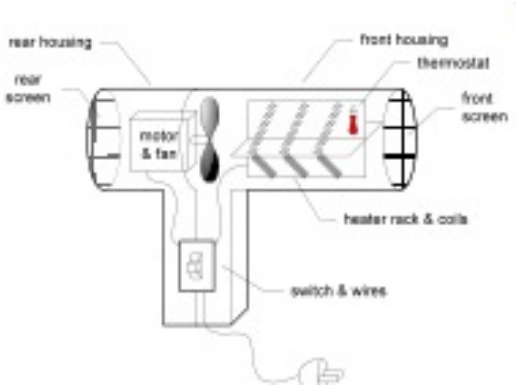
- BOM is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, components, parts and the quantities of each needed to manufacture an end product
- A BOM can be displayed in the following formats:
  - A **single-level BOM** that displays the assembly or sub-assembly with only one level of children. Thus it displays the components directly needed to make the assembly or sub-assembly.
  - An **indented BOM** that displays the highest-level item closest to the left margin and the components used in that item indented more to the right
- **Modular BOM** includes a description of the subassemblies and components

BOM Example

ITEM	QTY	MARK	DESCRIPTION	PART NUMBER	REMARKS
1	1	CB104	Circuit Breaker, 3-pole, 30 Amp, 480 VAC	G3P-030	
2	1	TRF107	Control Power Transformer, 230/460 VAC Pri., 115 VAC Sec., 250 VA	CPT115-250-F	
3	2	FU107, 109	Fuse, Class CC, Current Limiting, Fast-acting, 600 VAC, 1 AMP	HCLR1	
4	1	FU114	Fuse, Time Delay, 500 VAC, 2 AMP	MEQ2	
5	1	PB207	Pushbutton, 30mm, Momentary, Flush Head, Green, 1-NO Contact	HT8AAGA	
6	1	PB209	Pushbutton. 30mm, Momentary, Extended Head, Red, 1-NC Contact	HT8ABRB	
7	1	A	Contactor, 9 AMP, 110-120 VAC Coil	SC-E02-110VAC	Motor Starter A
8	1	OLA	Overload Relay, 6-9 AMPS Adjustable	TK-E02-900	Motor Starter A
9	1	LS308	Limit Switch, Side Rotary Lever, 1-NO and 1-NC Contact	ABP1H41Z11	
10	as req'd	n/a	Wire Duct with Cover, Grey, 2.25" X 3"	T1-2230G-1	

Functional Model Example





Hair Dryer

Reference: Stanford ME317 course

Example: Hot Glue Gun

- Reference: **THE ROCKET AVENGERS**
  - **PAUL SOWINSKI, TYLER MERRITT, and WILLIAM KRAMP**

List Design Issues

- Customer needs
  - Easy to use
  - Comfortable to handle
  - Results in good bonding
  - Light weight
  - Easy to maintain
  - Safe
- Cost: $15
- Weight: 400 gram
- Dimensions : 5 in height, 3.5 in length, 2 in thick
- Material: Plastic cover

Hot Glue Gun: Basic Function

- Hot glue gun uses a heating element to melt the plastic glue, which is pushed through the gun by a mechanical trigger mechanism
- The glue is supplied by solid cylindrical sticks of various diameters
- The glue squeezed out of the heated nozzle is initially hot enough to burn and blister skin
- The glue hardens in anywhere from a few seconds to one minute

Applications

- Hot melt adhesives are used to close fiberboard boxes and paperboard cartons
- Crafts in the home
- Assembly of parts in manufacturing
- Assembly and repair of foam model aircraft and toys.
- Hot melt adhesive is used for disposable diaper construction where it is used to bond together the nonwoven material with the backsheet and the elastics
- Hot glue is also frequently used to affix parts or wires in electronic devices
- Heat sometimes allows disassembly: Points of modern arrows, hockey sticks, etc.

Advantages

- Hot melt adhesives have several advantages over solvent-based adhesives
  - Hot melt adhesives do not lose thickness during solidifying while solvent-based adhesives may lose up to 50-70% of layer thickness during drying
  - Produce stronger bond
  - Volatile organic compounds are reduced or eliminated, and the drying or curing step of manufacture is eliminated
  - Hot melt adhesives have long shelf life and usually can be disposed of without special precautions

Prepare for teardown

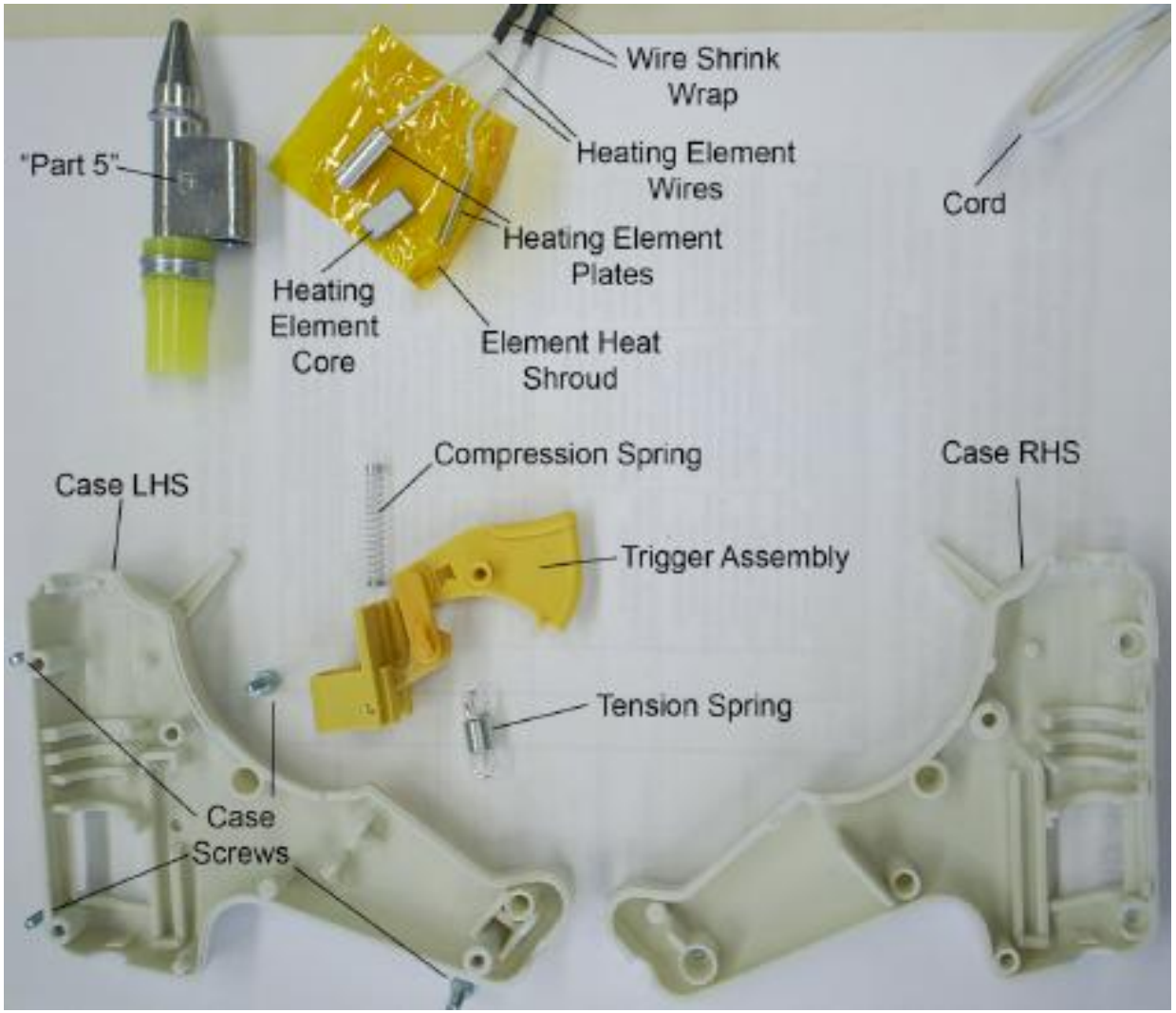
- Tools needed
  - Screw driver: Phillips head
  - Camera
  - Ruler
  - Tape
  - Temperature sensor
  - Current meter

Product with ruler

Disassemble and Analyze

- Teardown the product and provide the following documents
  - Exploded View
  - Descriptive BOM
  - Functional Model

Exploded Image

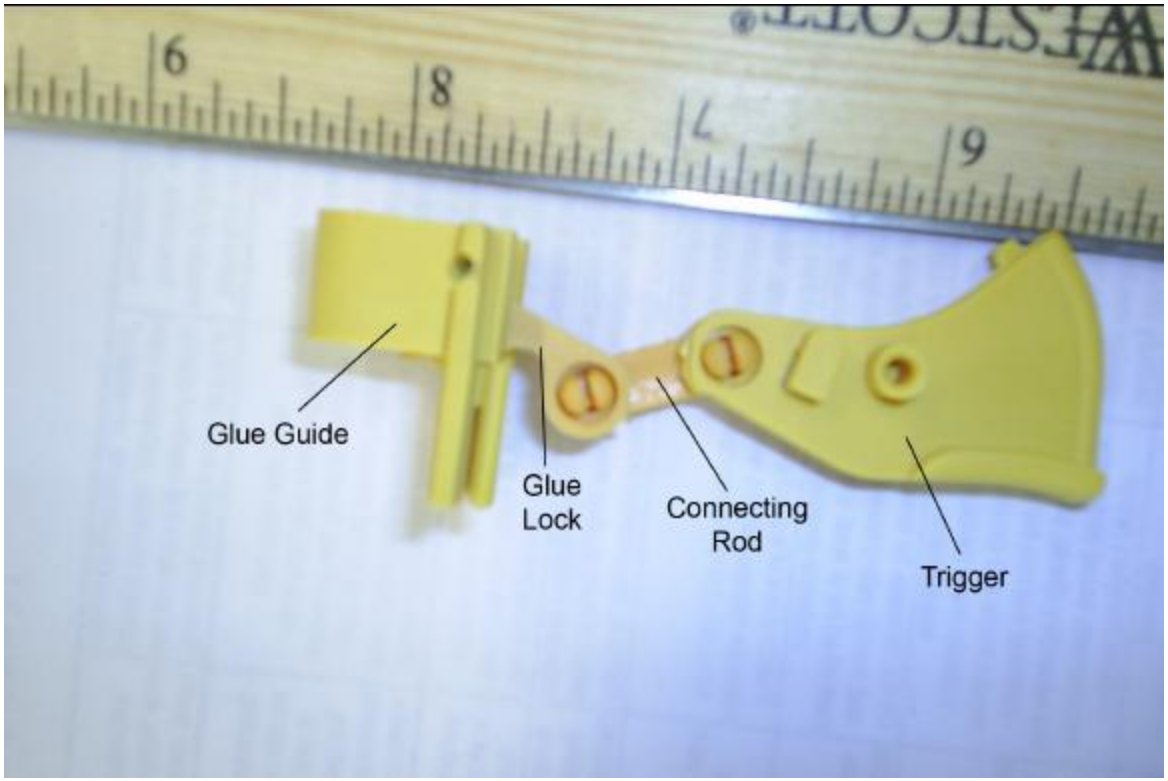


Subassemblies and Components

- Product Teardown 28 pieces

- (1) Plastic packaging: protect and display product for purchase.
  - (4) Exterior screws: hold case halves together.
  - (1) Right case half: acts as part of a handle and contains the rest of the parts.
  - (1) Left case half: acts as part of a handle and contains the rest of the parts.
  - (1) Short flat spring: provides resistance for trigger?
  - (1) Long skinny spring: provides a returning force for the trigger.

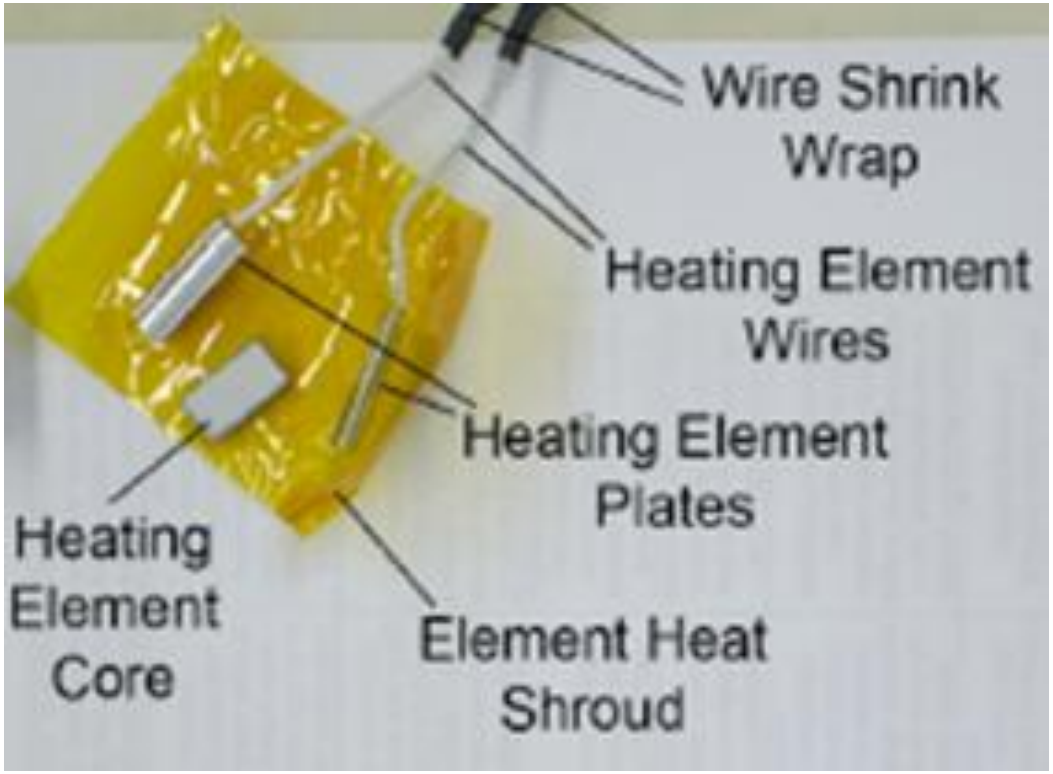
Trigger Assembly



Subassemblies and Components

- (1) Trigger assembly:
  - (1) Trigger: acts a activation of glue gun operation.
  - (1) Linkage arm: connects trigger to rest of trigger assembly.
  - (1) Glue clamp: clamps glue stick to be fed into heating element.
  - (1) Clamp shaft: connects clamp to rest of trigger assembly.
  - (1) Glue guide: guides glue into heating element.

Heating Element



Subassemblies and Components

- (1) Heating element assembly:
  - (1) AC cord: transfers electrical energy from wall outlet to heating element
  - (2) Heat shrink sleeves: cover and protect connection from AC cord to smaller wires
  - (2) Small wires: transfers electrical energy from AC cord to heating pads.
  - (2) Heating pads: convert electrical power to heat.
  - (1) Rectangular block: heating element core.
  - (1) Heating element shroud: contains heating pads and rectangular block and separates pads from casing

Guide and Metal Part

Subassemblies and Components

- (1) Guide and Metal
  - (1) Rubber guide: guides glue into part # 5 casing.
  - (1) Clamp: clamps rubber guide to part # 5 casing

  - (1) Metal part # 5 casing:
    - (1) Check ball valve in tip: stops glue from flowing when no pressure is on trigger.
    - (1) Valve backing plate: holds check ball valve in place.
    - (1) Check ball valve spring: returns check ball valve to closed position

Single level BOM

Table 1. Master BOM

Item #	Assembly	Quantity
A	Plastic Package	1
B	Trigger Assembly	1
C	Heating Assembly	1
D	Guide and Metal	1

Table 2. Package BOM

Item #	Assembly	Quantity
A1	Right case half	1
A2	Left case half	1
A3	Short spring	1
A4	Long spring	1
A5	Screws	4

Indented BOM

Item #	Assembly	Quantity
A1. Plastic Package		
01	Right case half	1
02	Left case half	1
03	Short spring	1
04	Long spring	1
05	Screws	4
A2. Trigger Assembly		
06	Trigger	1
…	…	…
A3. Heating Assembly		
…		
A4. Guide and Metal		
…		

Indented Modular/Descriptive BOM

Item #	Assembly	Qty	Description
A1. Plastic Package			
01	Right case half	1	Plastic. Contains the rest of the parts
02	Left case half	1	…
03	Short spring	1	…
04	Long spring	1	…
05	Screws	4	…
A2. Trigger Assembly			
06	Trigger	1	…
…	…	…	…
A3. Heating Assembly			
…			
A4. Guide and Metal			
…			

Product Function Model