ME450: FUNCTIONAL DECOMPOSITION

Function vs. form:

Function describes what a product will do
Form indicates how the product will perform the function

Function is described in terms of the logical flow of energy, material, or information

Consider: Energy (mechanical, electrical, fluid, thermal, optical…)
Through flow, diverging flow (branching), converging flow
Information signals (mechanical, electrical, software, optical)

Process of Functional Decomposition:

1. Define the overall function that needs to be accomplished
   Make a single, concise statement of the most important functions of the design
   (Recall the previous assignment, this is the Problem Definition)

2. Decompose the function into subfunctions

   1. Document what (function), not how (form)
      Form follows from function, so consider form after function has been defined
   2. Use standard notation when possible
      Employ the standard notation for the type of system you are developing, such as circuit diagrams, hydraulic system schematics, pseudocode for software
   3. Establish logical flow
      Place functions in a logical sequence, and employ well-defined logical functions, such as AND, OR, NOT
   4. Match inputs and outputs
      Function must include all required transformations of energy, materials, or information
   5. Break the functions down as finely as possible

Functional Decomposition usually takes the form of a block diagram or an outline:

Example: a syringe

Design Problem: Provide a safe and inexpensive method to allow small amounts (0.01 to 1.00 cc) of sterile fluid to be injected subcutaneously or into a sealed container

Functional decomposition:

Level 1:

1. Maintain sterile conditions (sterile storage, needle placement, …)
2. Withdraw a fixed amount of fluid from a container
3. Remove air bubbles
4. Adjust total volume of fluid
5. Transport fluid to person or container
6. Inject fluid
7. Dispose safely

Decision: use standard needles and fittings (Luer fittings)

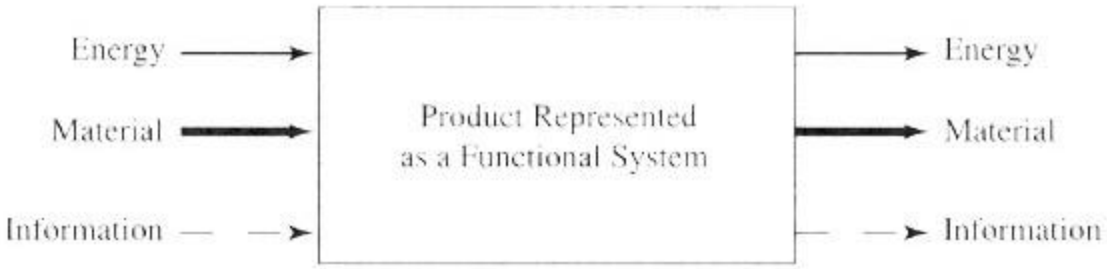
Level 2:

1. Maintain sterile conditions
    - 1.1 Sterilize needle and syringe
    - 1.2 Package needle and syringe in sterile containers
    - 1.3 Allow needle and syringe to be assembled safely
2. Withdraw a fixed amount of fluid from a container
    - 2.1 Insert needle through seal into fluid
    - 2.2 Invert fluid container to submerge open end of needle
    - 2.3 Withdraw fluid from container into syringe
3. Remove air bubbles
    .
    .
4. Adjust total volume of fluid
    .
    .
5. Transport fluid to person or container
    .
    .
6. Inject fluid
    .
    .

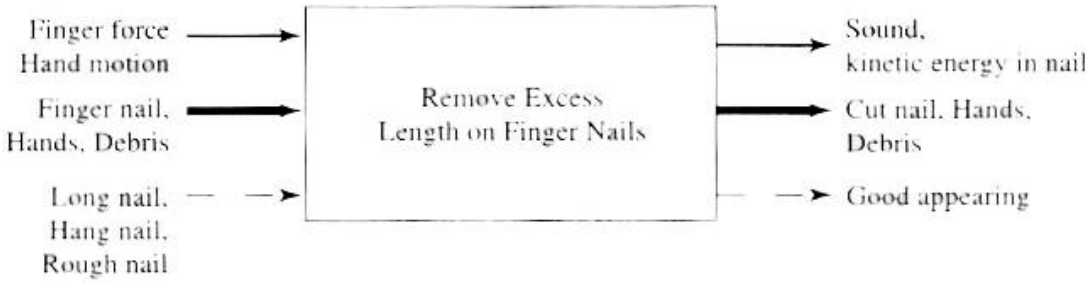
This could be drawn in the form of a block diagram
This is a simple example because an excellent design solution already exists
For novel or complex design problems, the functions can be broken down almost infinitely

AT THIS POINT, FOCUS ON <u>FUNCTION</u>, NOT <u>FORM</u>

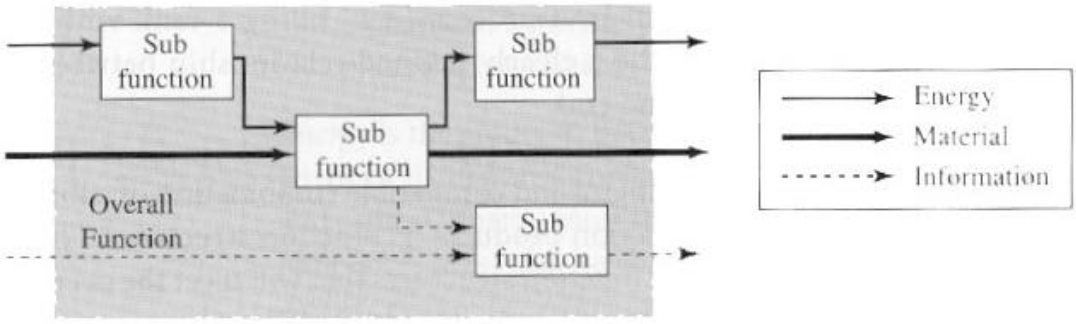
You may elect to do a functional decomposition as a bulleted outline, or you may decide to do a flow chart. For the flow chart, you want to consider the flow of Energy, Material, and Information as the product performs the function for which it was designed.
The general block diagram for Functional Decomposition is given below

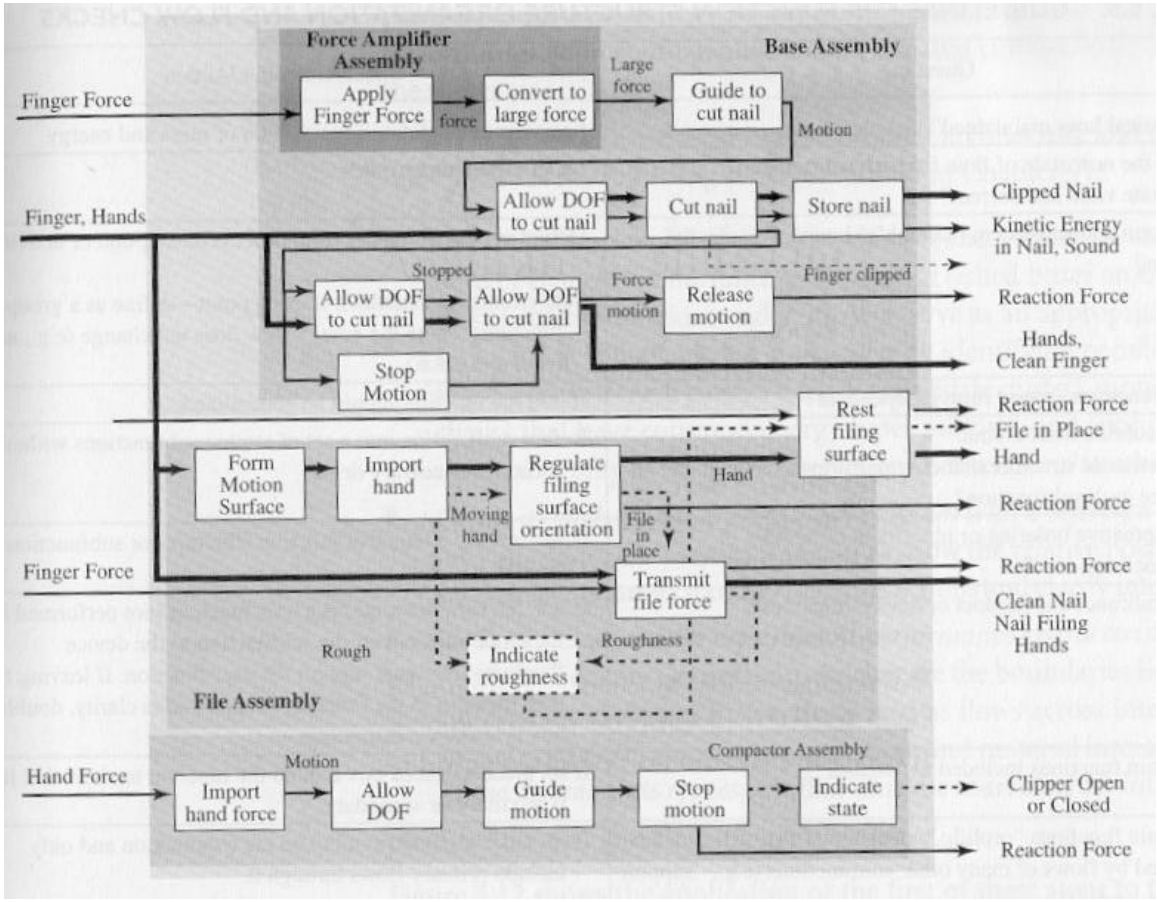


An example for a fingernail clipper is given below:



Inside the box, the various functions of a fingernail clipper are given in terms of functions and subfunctions, as shown in the two diagrams below:





EXERCISE:
Each team must develop a Functional Decomposition for their Project. On a separate piece of paper, work out the most detailed Functional Decomposition that you can. Remember: stick to *function*, avoid defining *form* at this point.