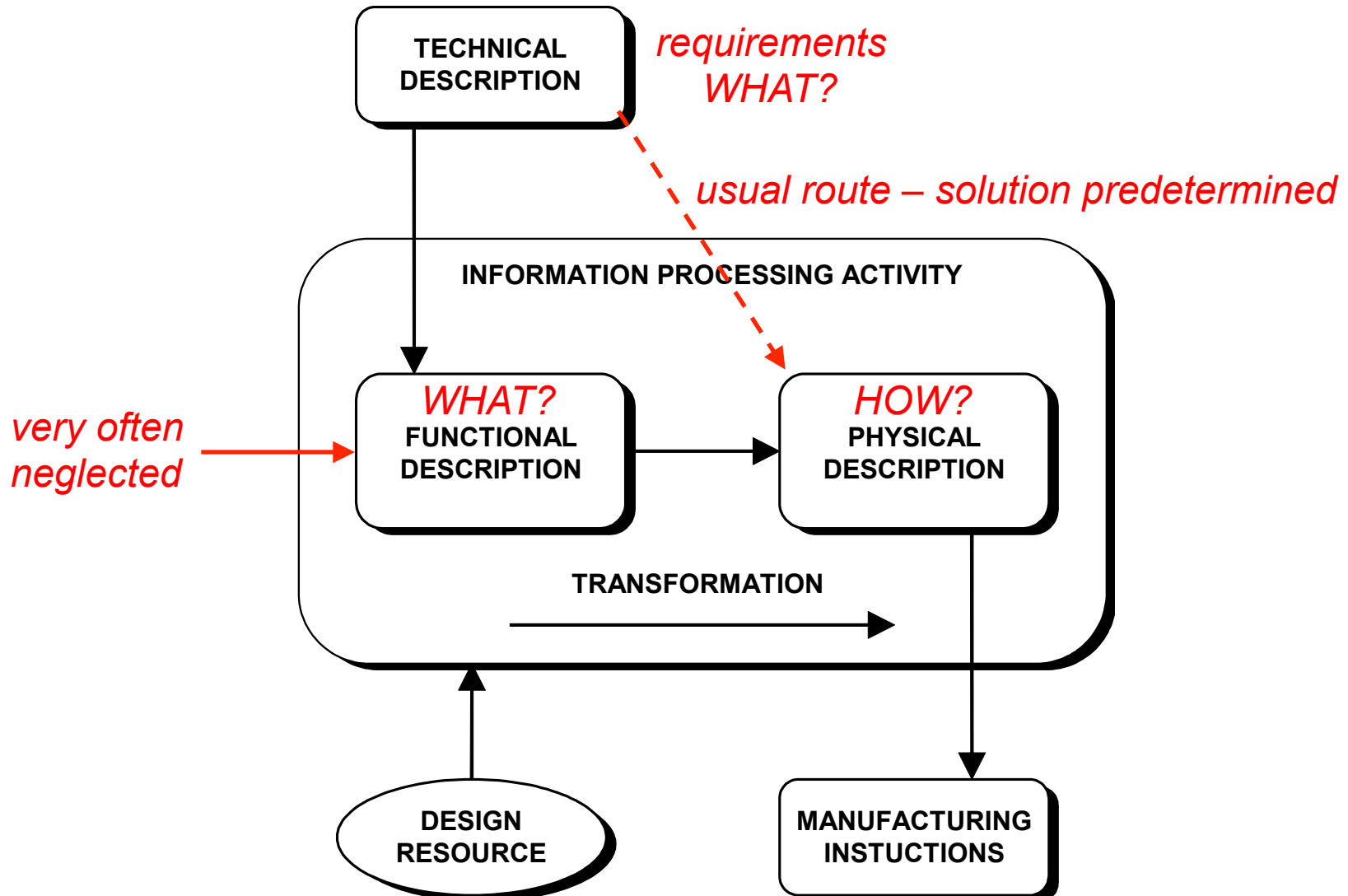


# Conceptual design

# TASK CLARIFICATION



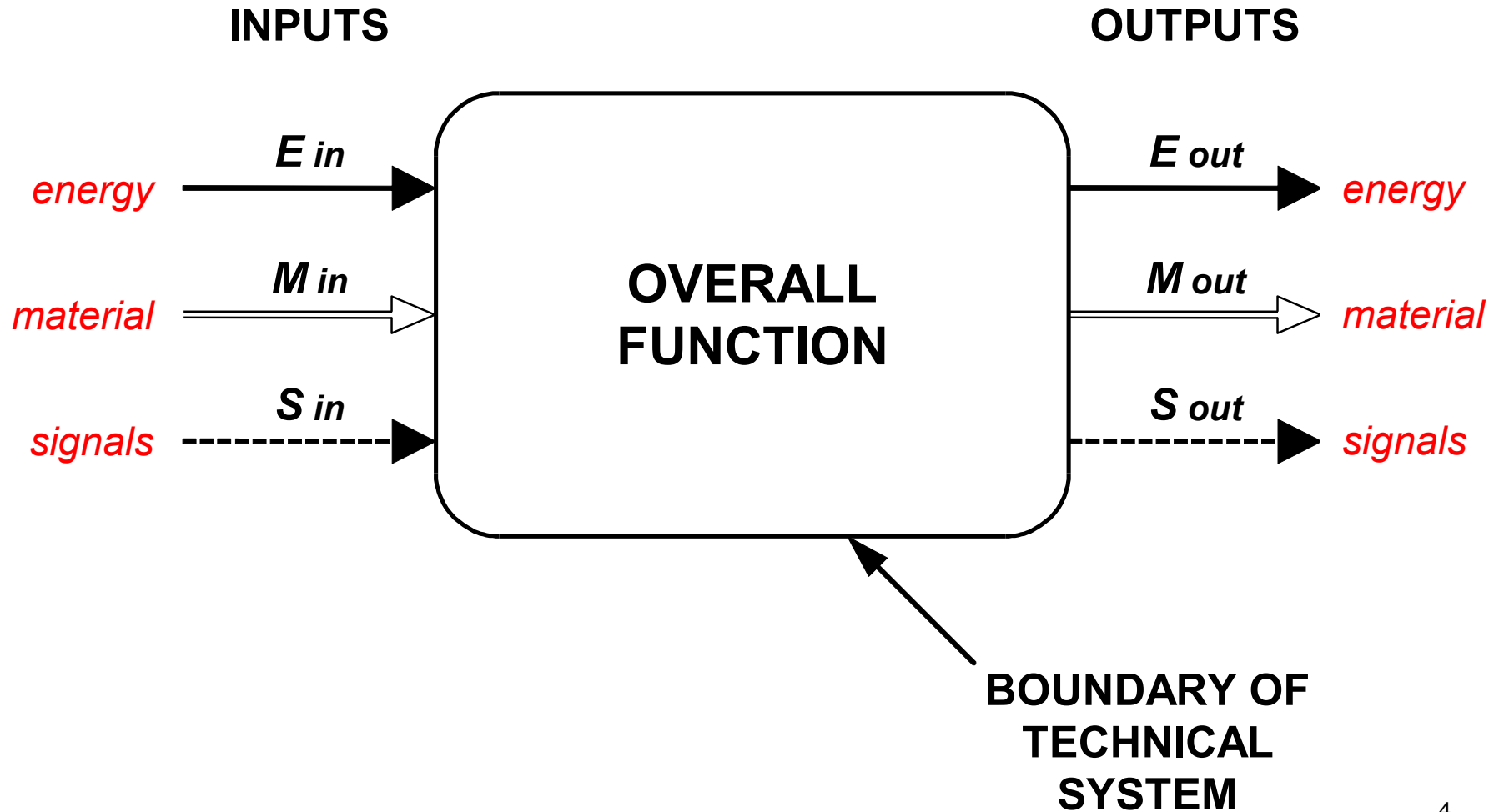
# TASK CLARIFICATION

Functional modelling is a means of determining and representing the functional description of a system.

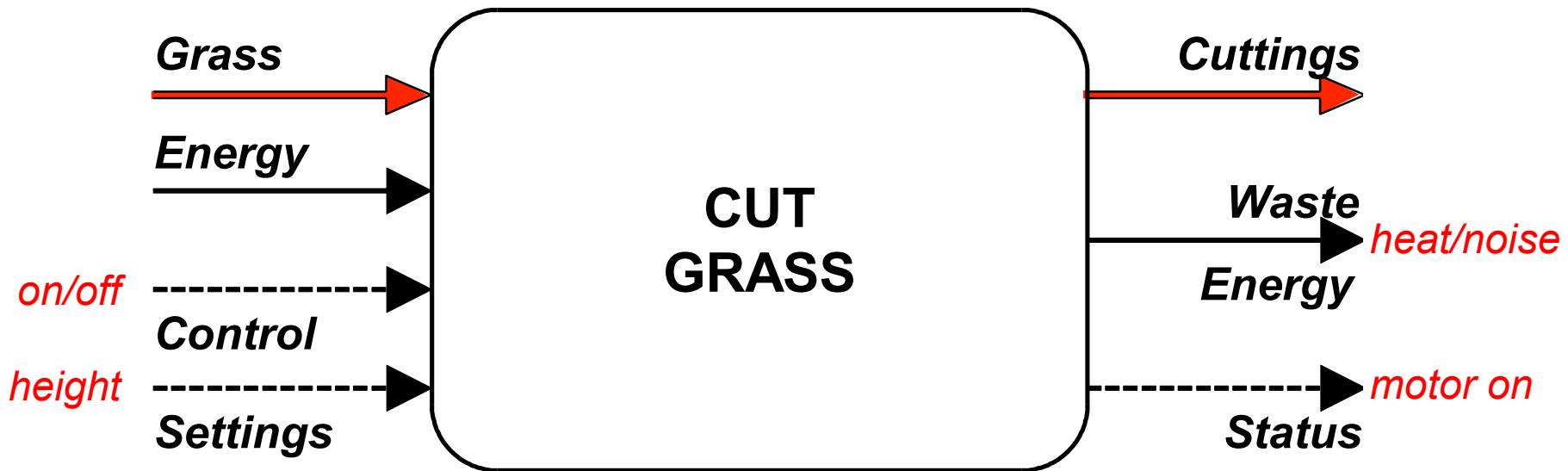
It has the following steps:

- *Determination of the overall function*
- *Establishment of function structures*
- *Generation and selection of suitable combinations*

# DETERMINING THE OVERALL FUNCTION



# GRASS CUTTER



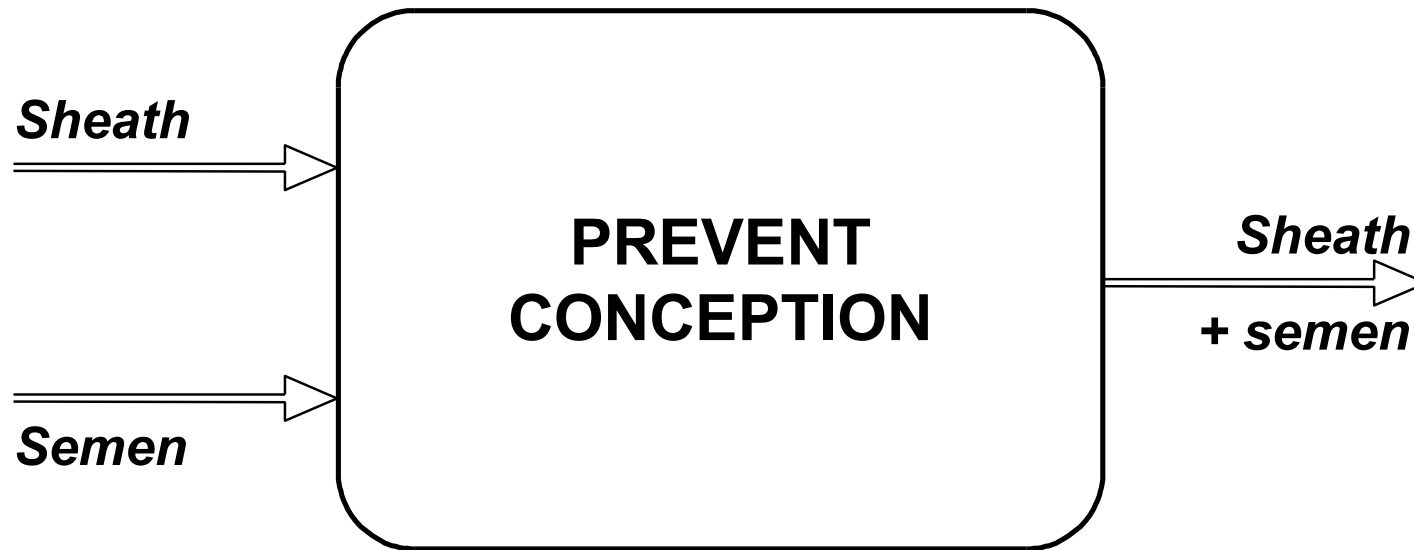
# ASTHMATIC INHALER



# DRAUGHT BEER IN A CAN



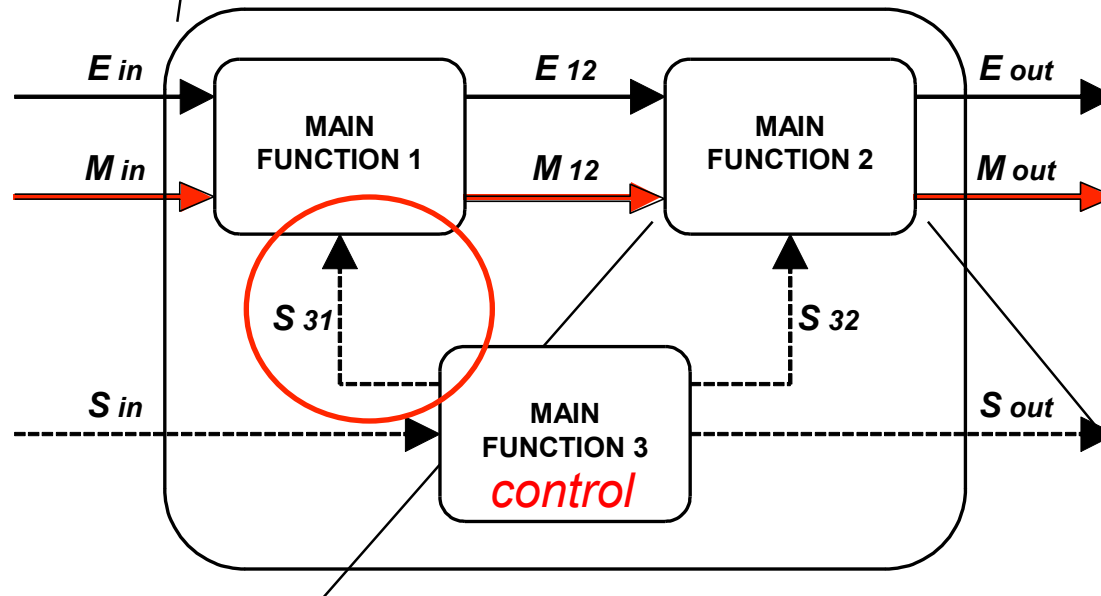
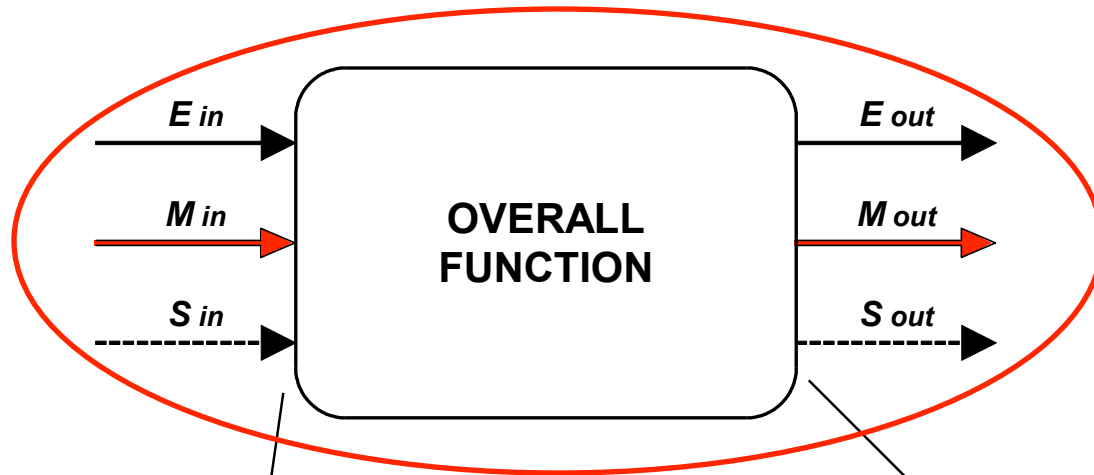
# FEMALE CONDOM



*not helpful?*

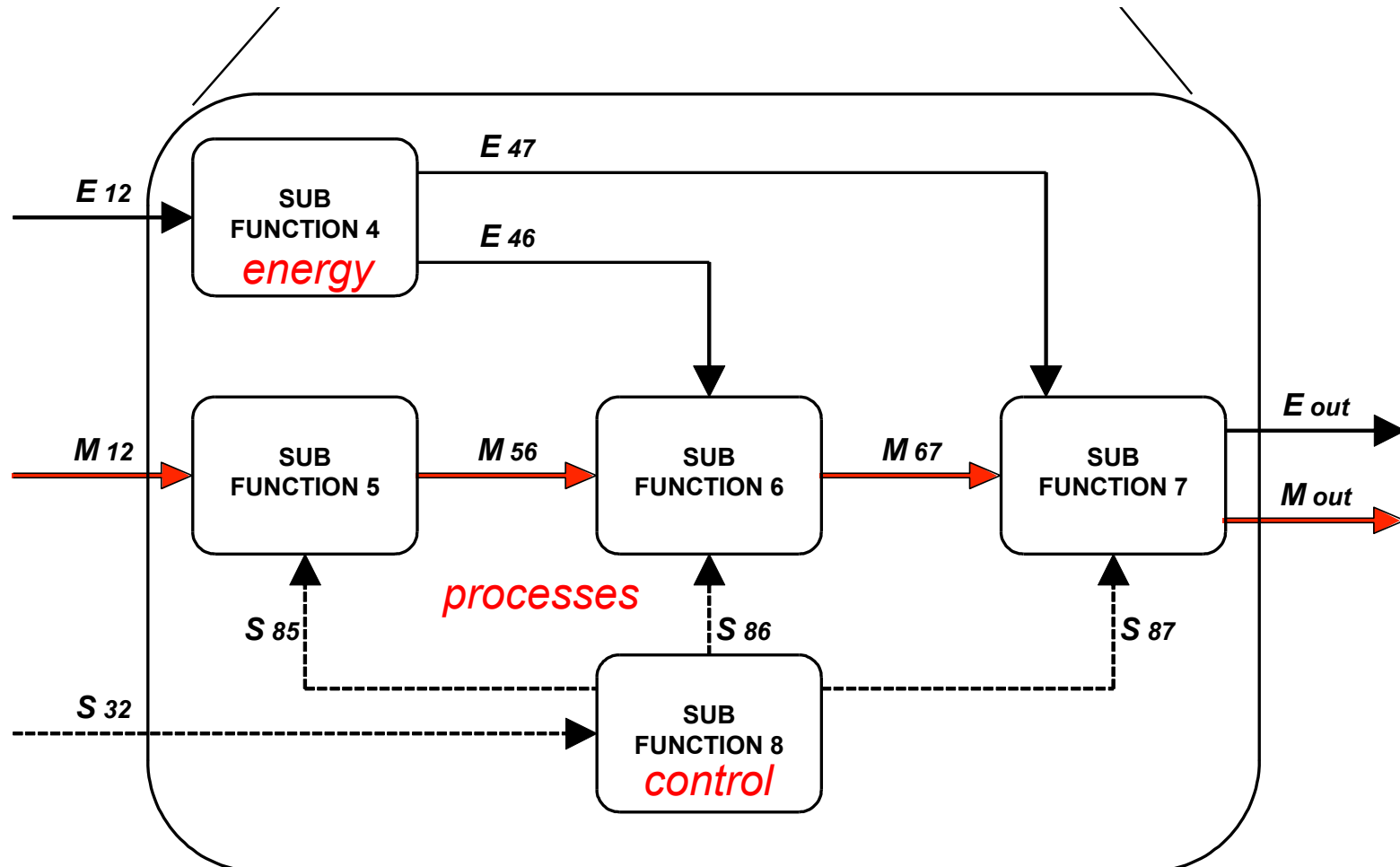


# ESTABLISHING FUNCTION STRUCTURES

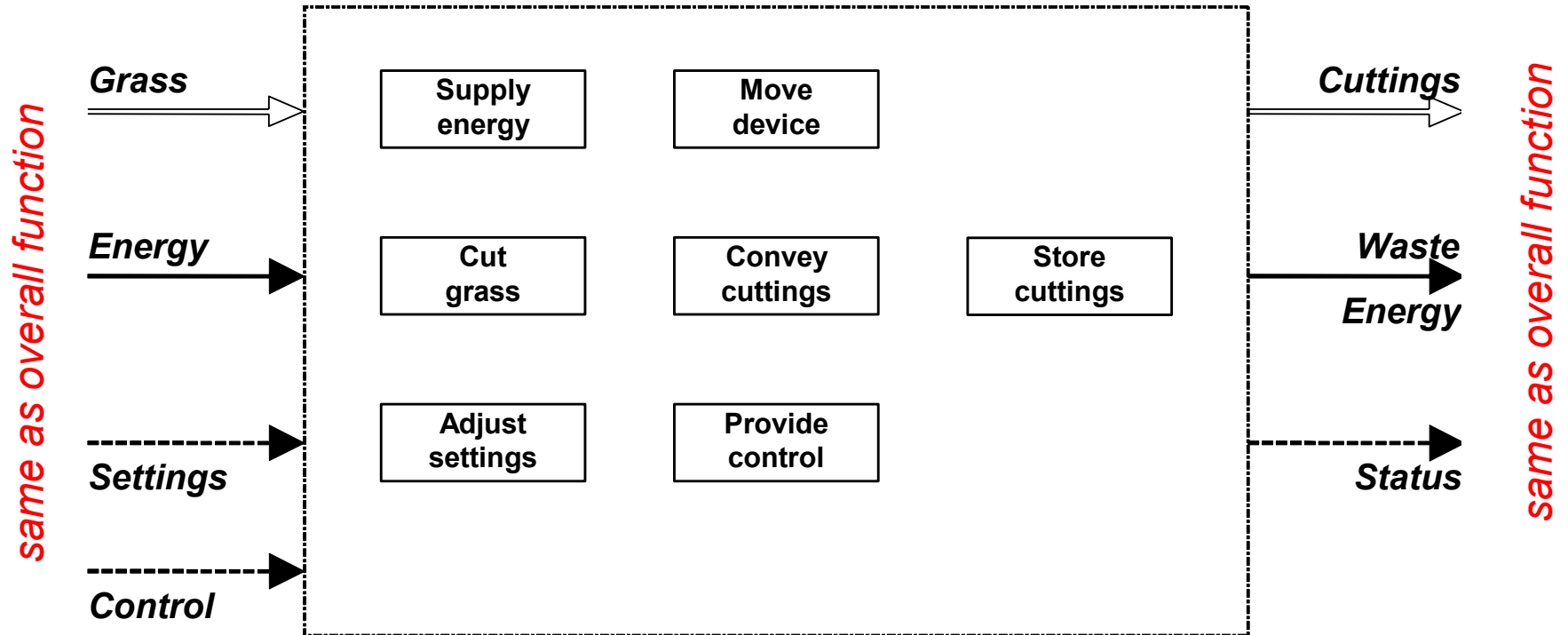


*clarity  
consistency  
completeness*

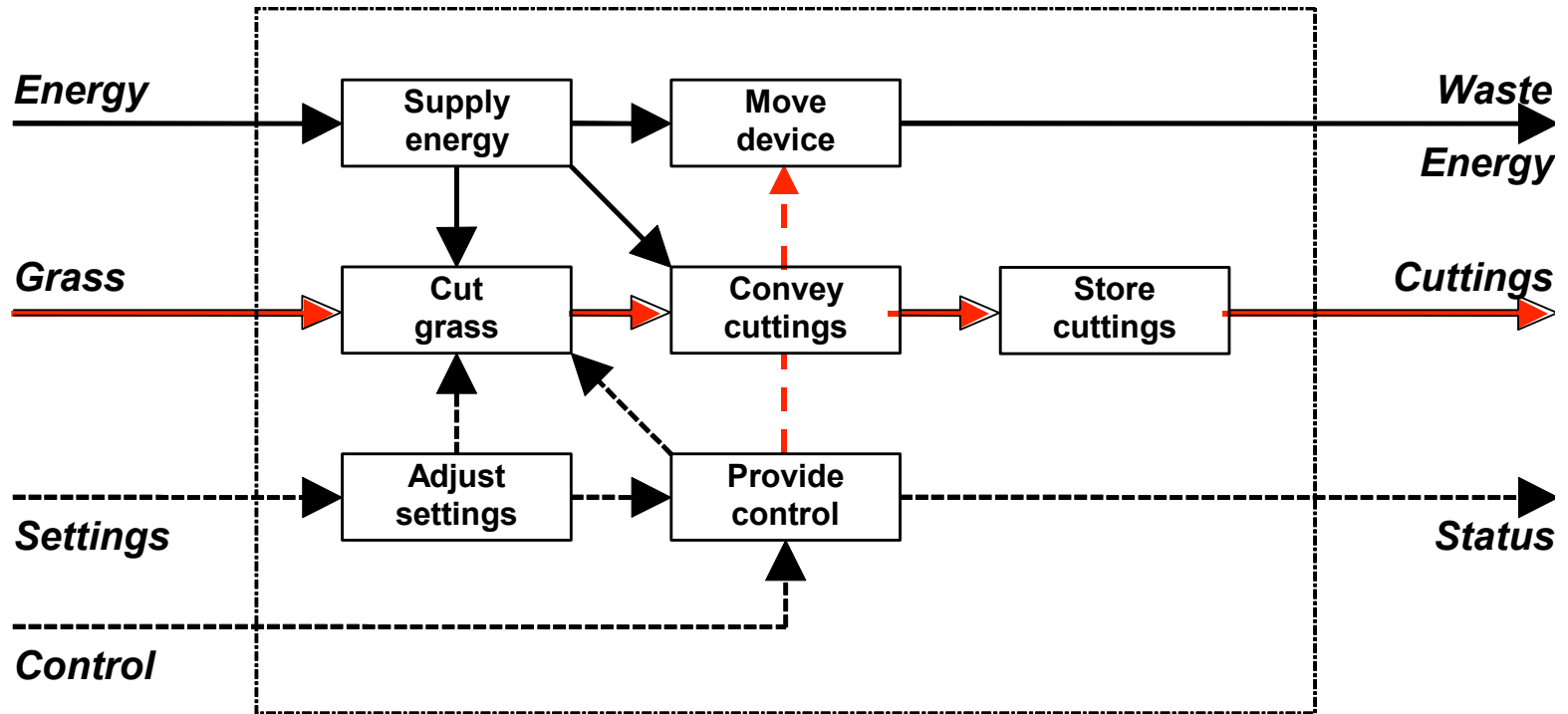
# ESTABLISHING FUNCTION STRUCTURES



# GRASS CUTTER



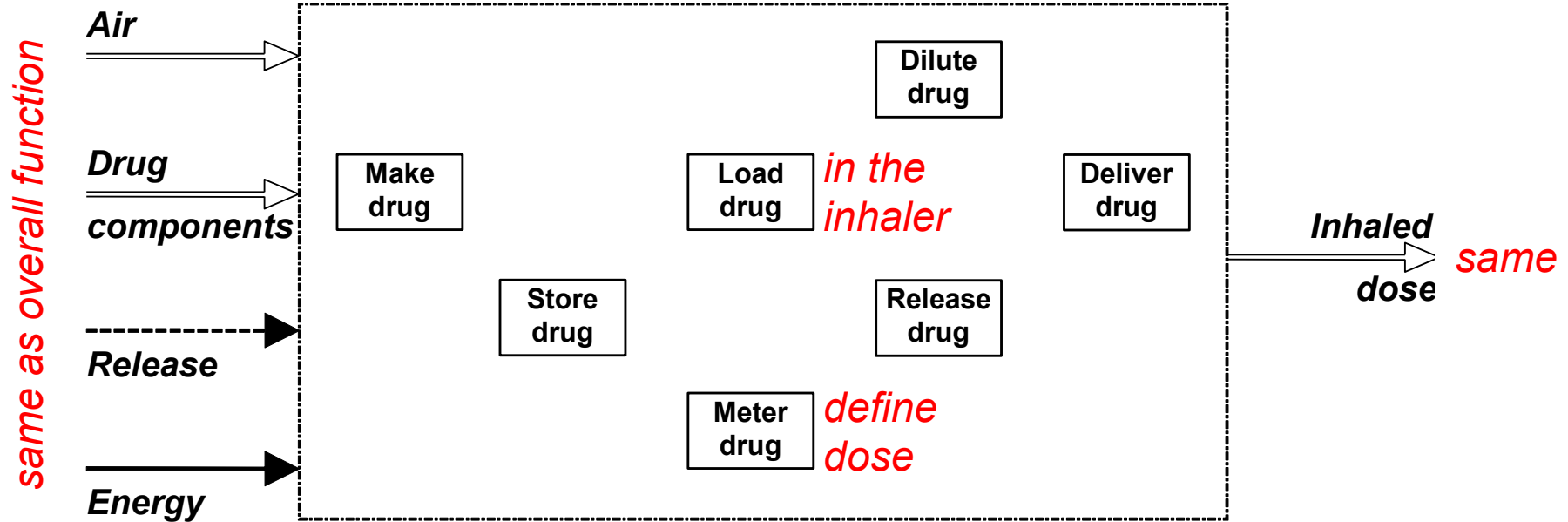
# GRASS CUTTER



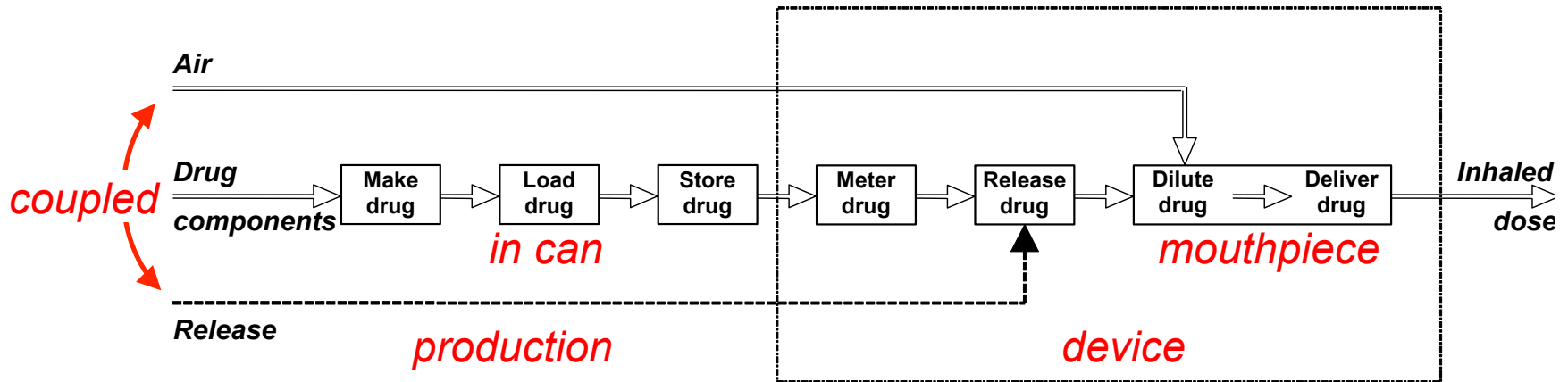
*alter specification to  
reflect new insights*

*helps the design team  
to understand the problem*

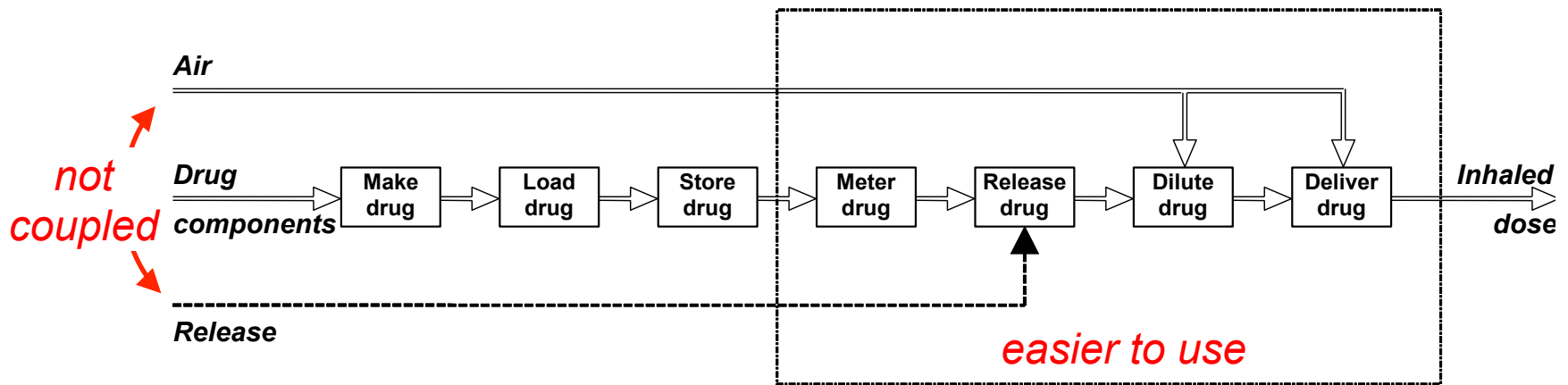
# ASTHMATIC INHALER



# ASTHMATIC INHALER

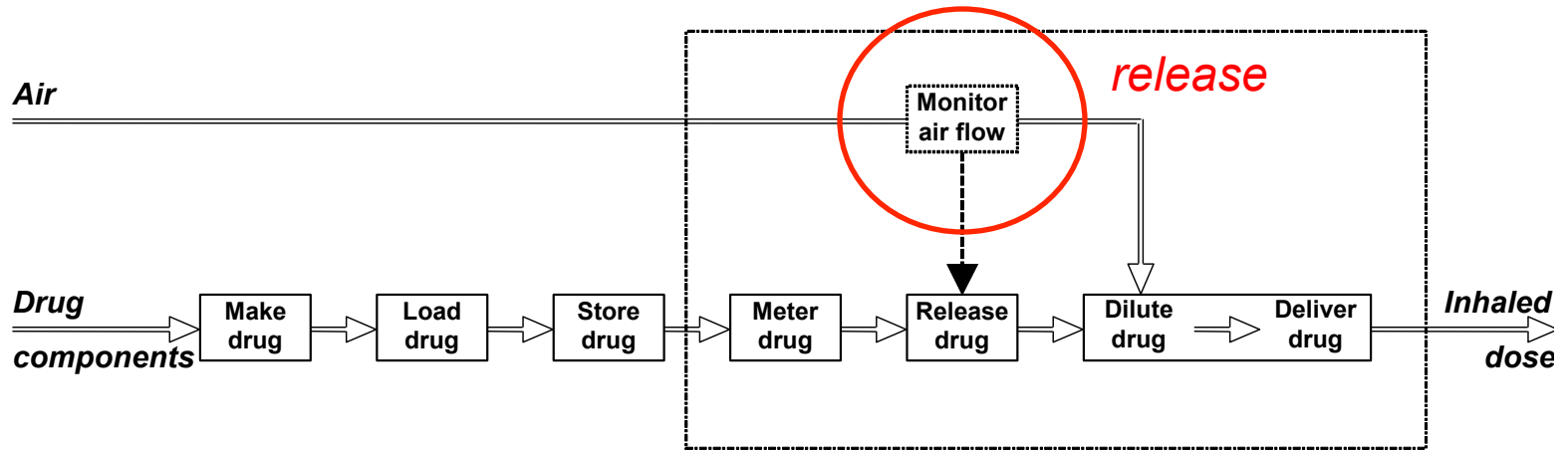


**Multi-dose inhaler**

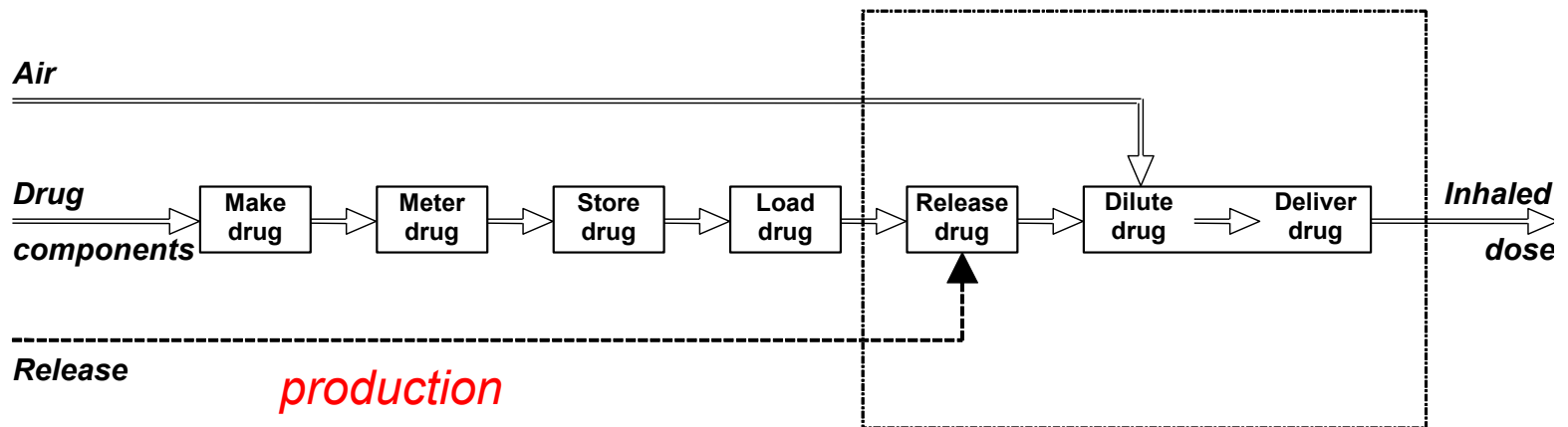


**Multi-dose inhaler with spacer**

# ASTHMATIC INHALER

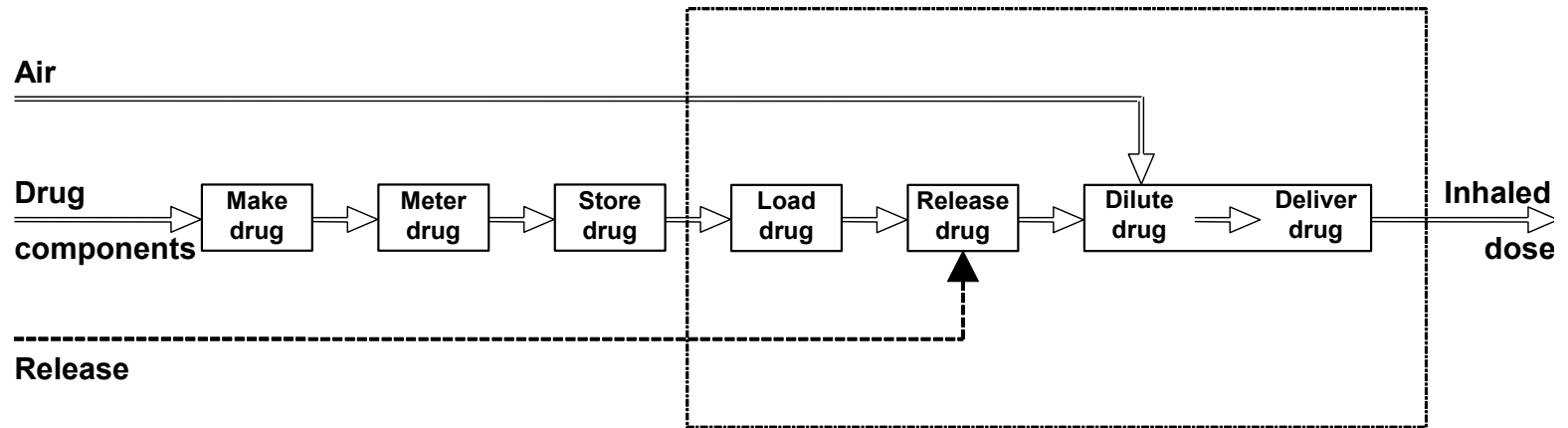


**Breath operated inhaler**

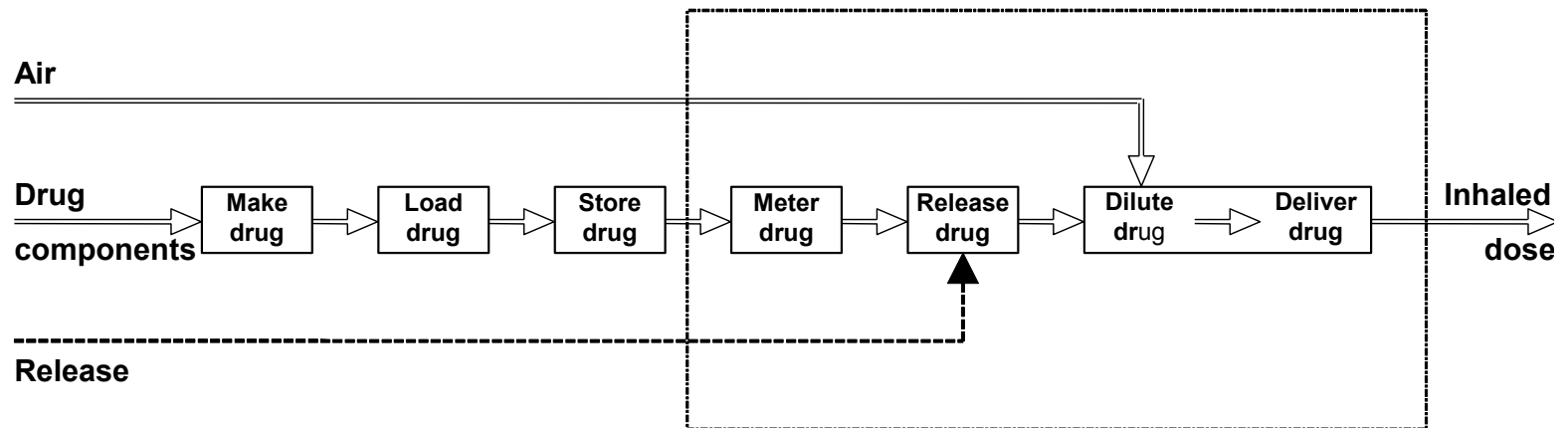


**Diskhaler**

# ASTHMATIC INHALER



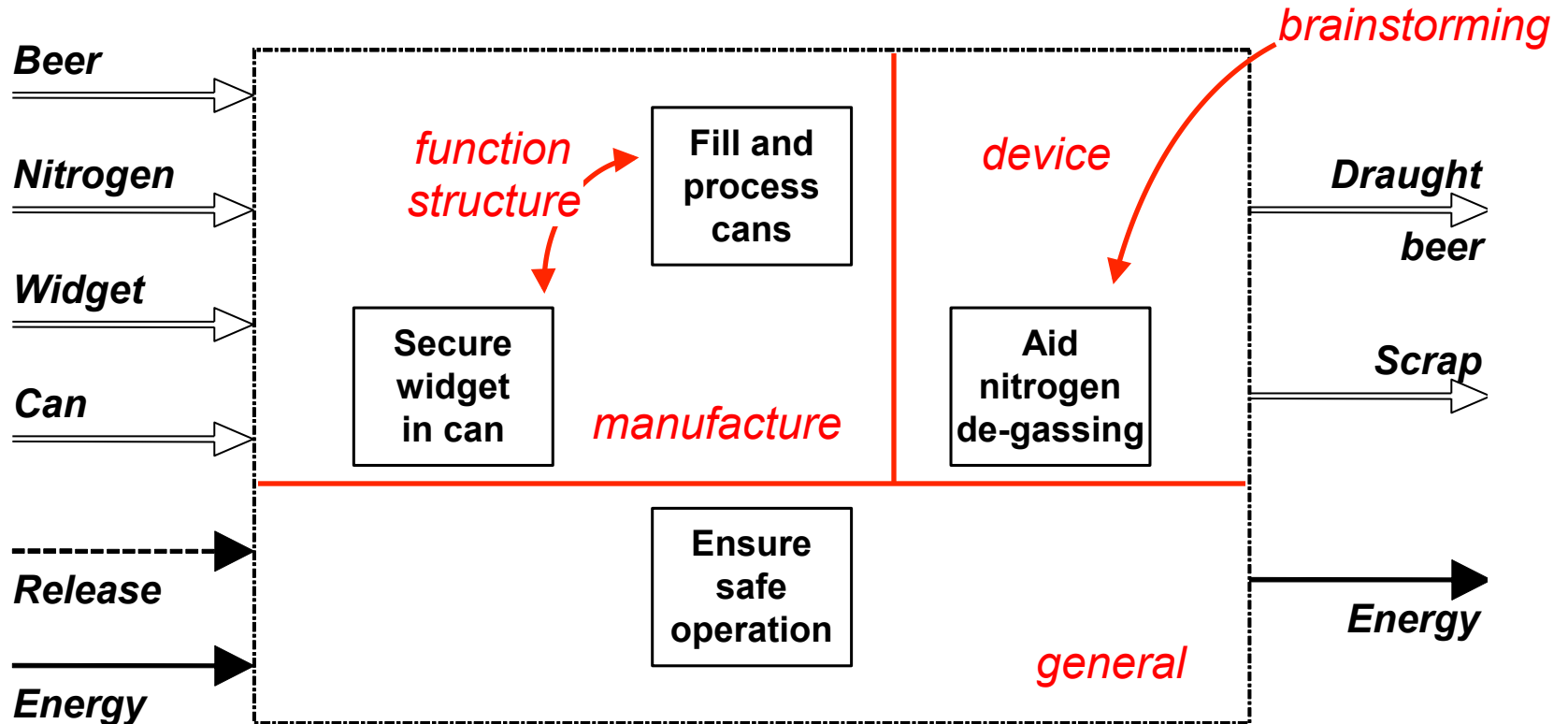
*Rotohaler*



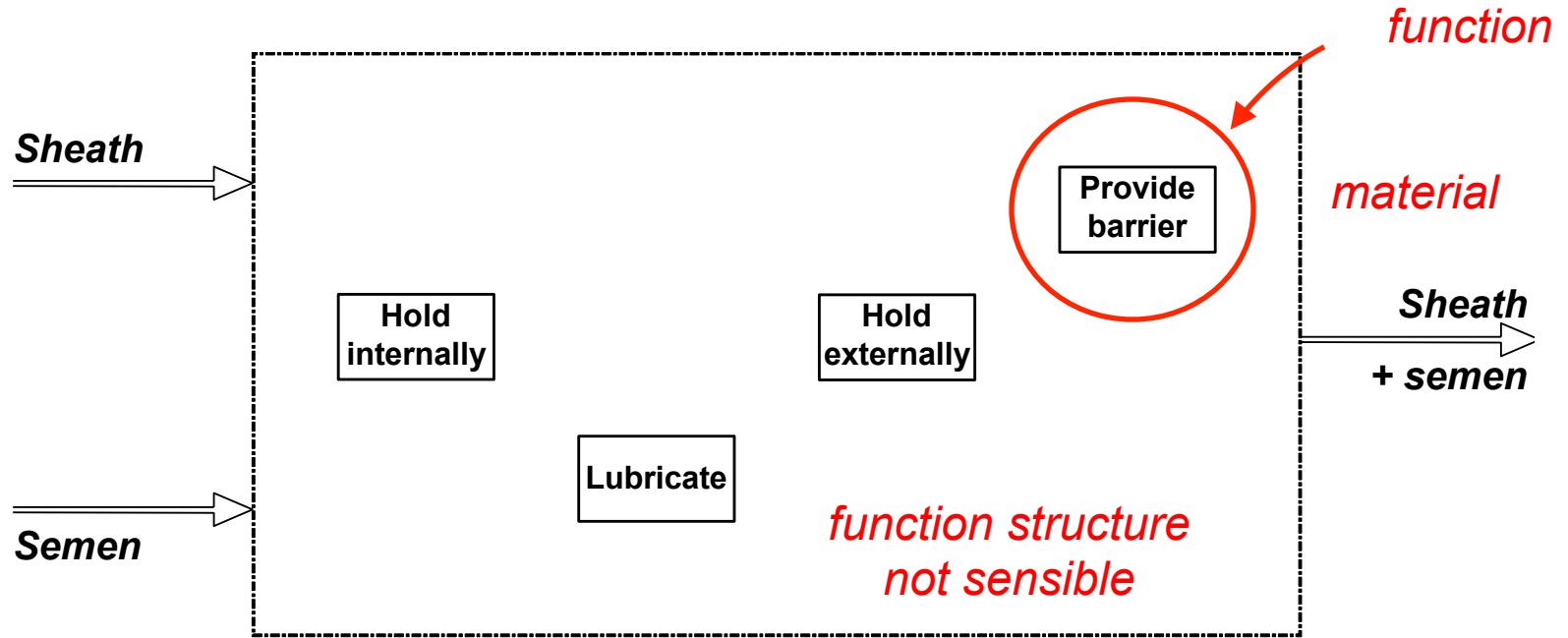
*Turbohaler*



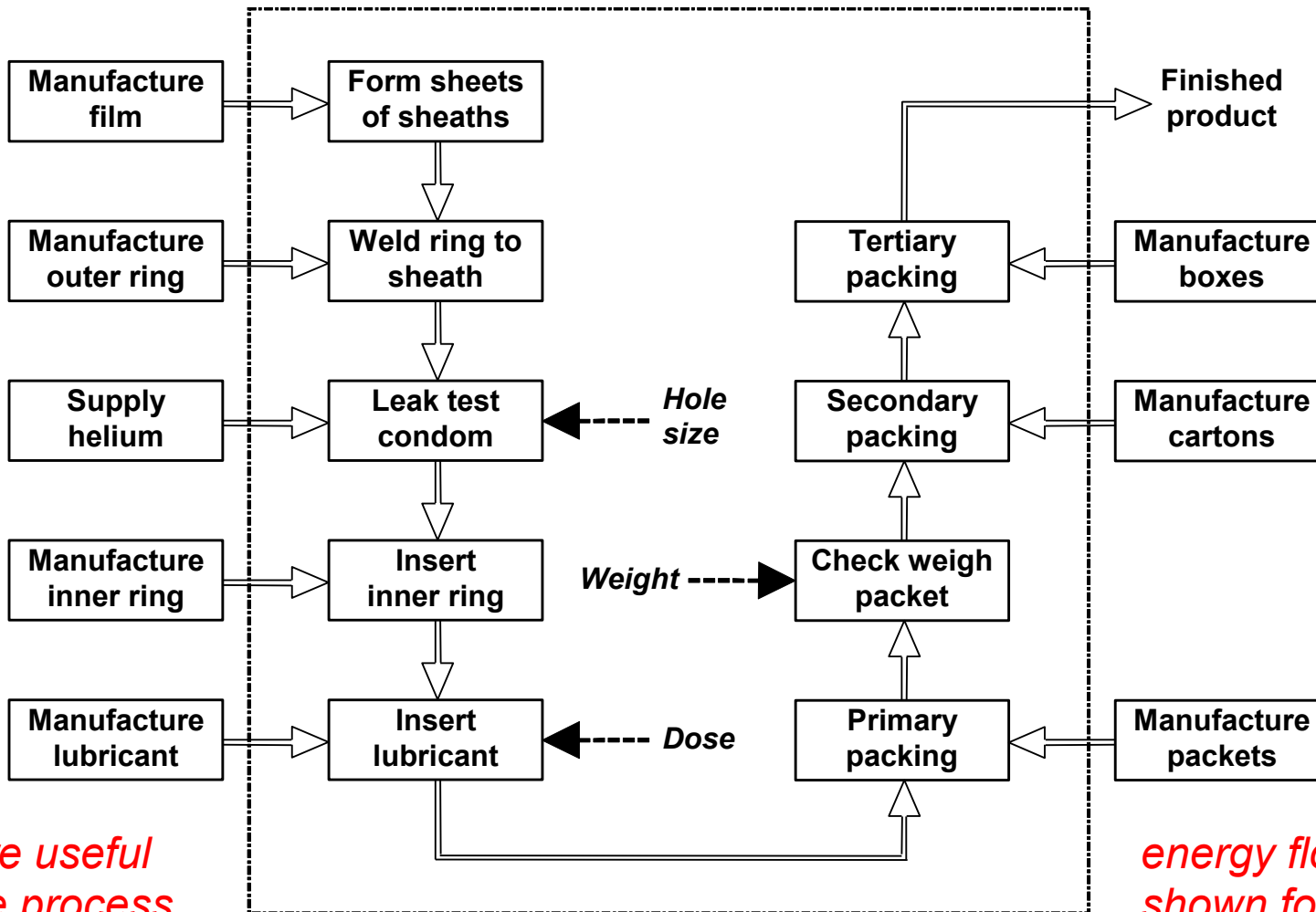
# DRAUGHT BEER IN A CAN



# FEMALE CONDOM



# FEMALE CONDOM

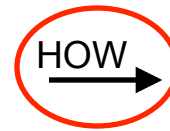


*far more useful  
to define process*

*energy flows not shown for clarity*

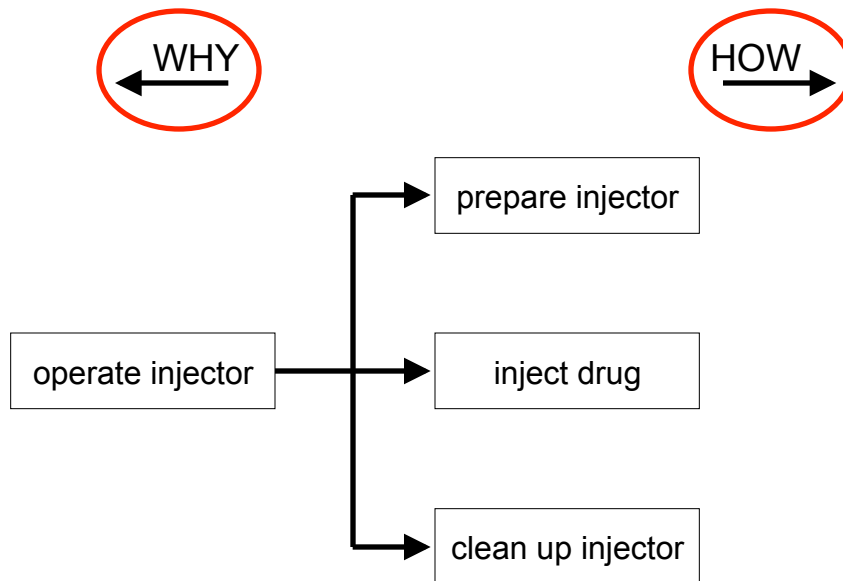
## ***New production facility***

# FAST DIAGRAM



operate injector

# FAST DIAGRAM

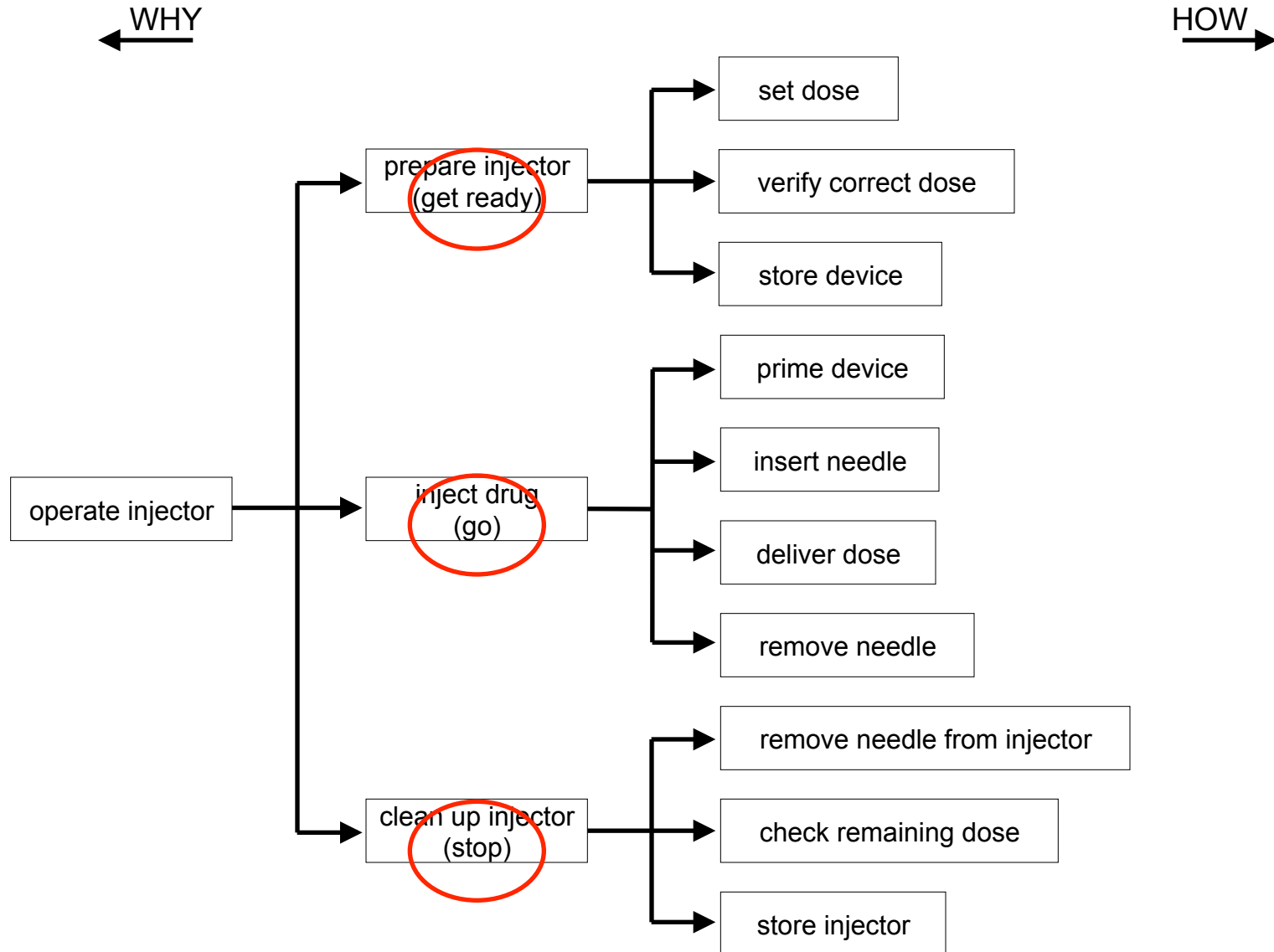


# FAST DIAGRAM

Constructing the FAST diagram has the following steps:

- Start with general functions and get progressively more specific
- Each function should be a verb and a noun (keep it as simple as possible)
- Chronologically trace through each function that must be accomplished
- Be sure to include all special modes of operation such as stand-by, run, cleaning, etc.
- Avoid specifying form, structure or solutions; describe behaviour, not embodiment
- Customise the FAST diagram; the more information that can be visualised, the more useful the diagram

# FAST DIAGRAM



# ELABORATION OF FUNCTIONS

Important Function:

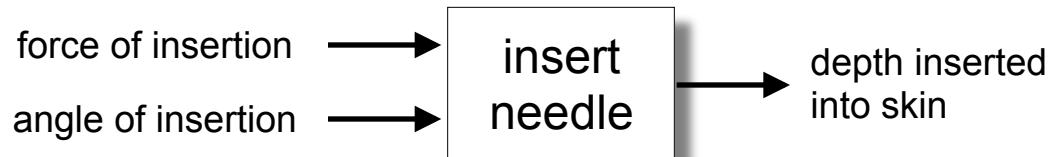
insert  
needle

- critical function*
- harm patient if extreme
  - injection will not be effective if fails



# ELABORATION OF FUNCTIONS

Controlled parameters:



*as it should operate*

# ELABORATION OF FUNCTIONS

Controlled parameters:

force of insertion



angle of insertion



insert  
needle



depth inserted  
into skin

*possible variations*



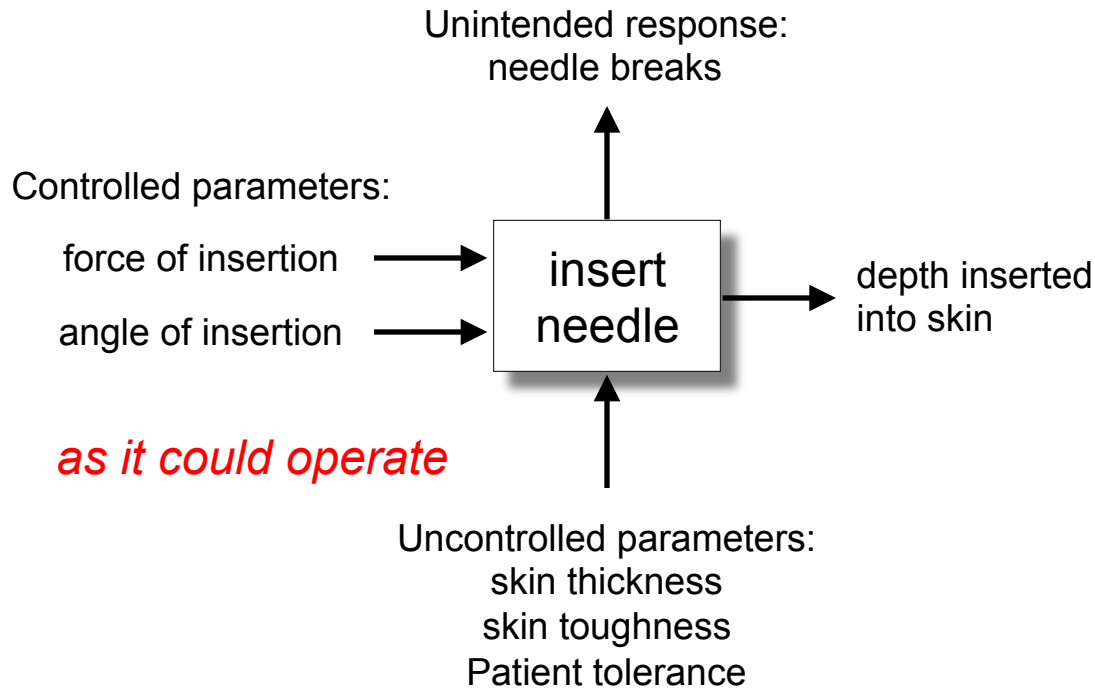
Uncontrolled parameters:

skin thickness

skin toughness

patient tolerance

# ELABORATION OF FUNCTIONS

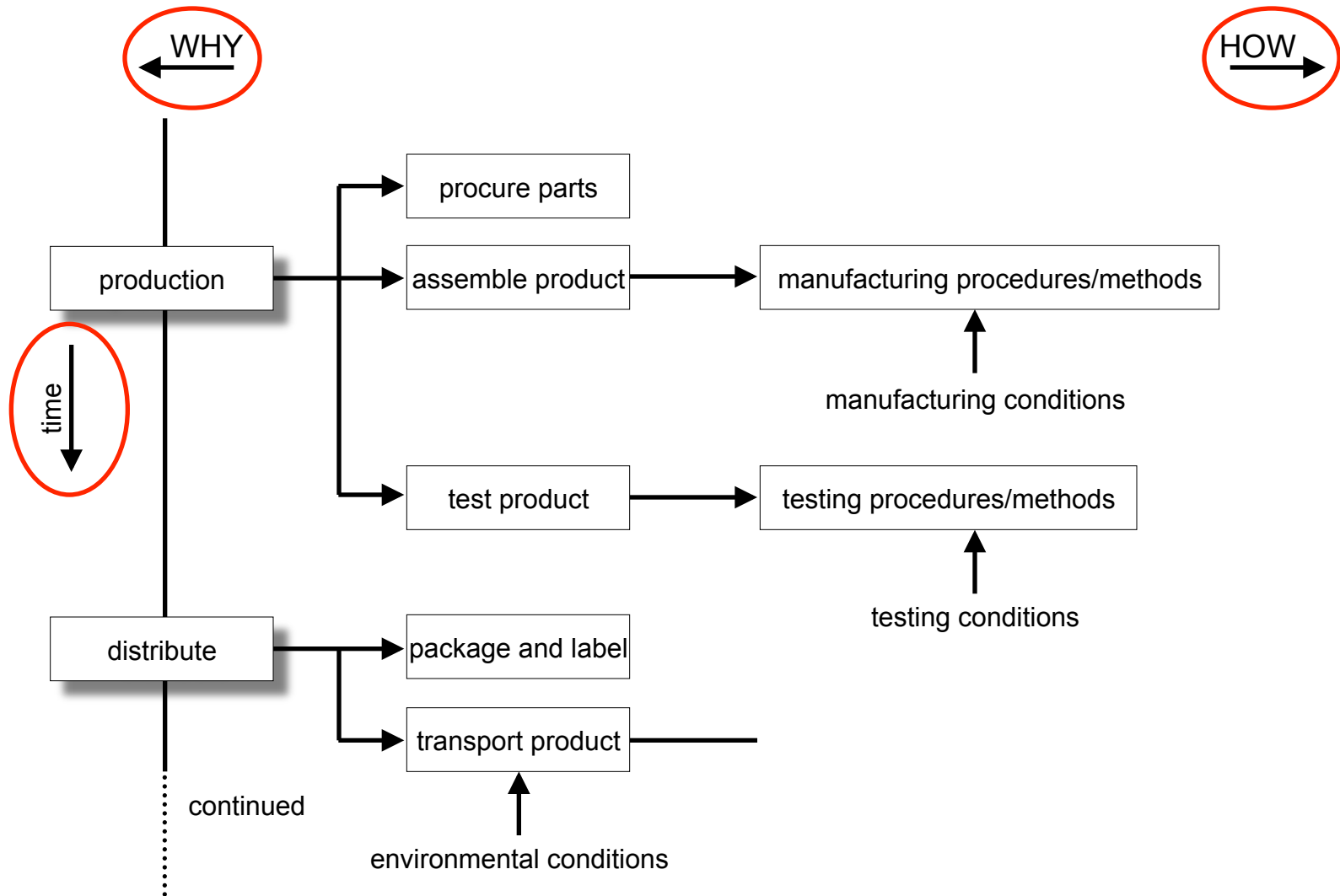


# LIFE CYCLE ANALYSIS

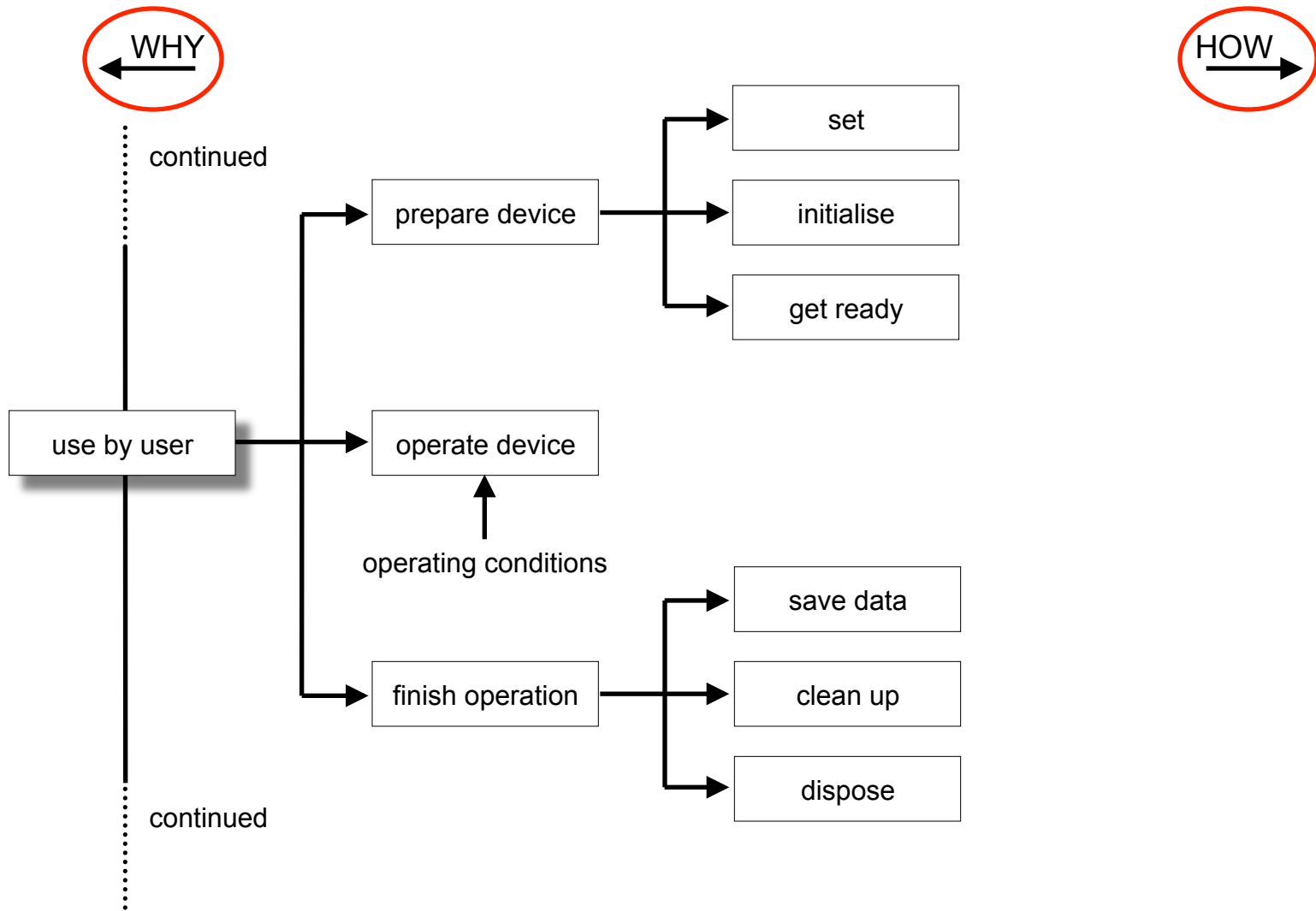
Constructing the FAST diagram can be prompted by the following questions:

- How well?
- How long?
- How fast?
- How safe?
- How much?
- How soon?
- How recorded?
- How ...?

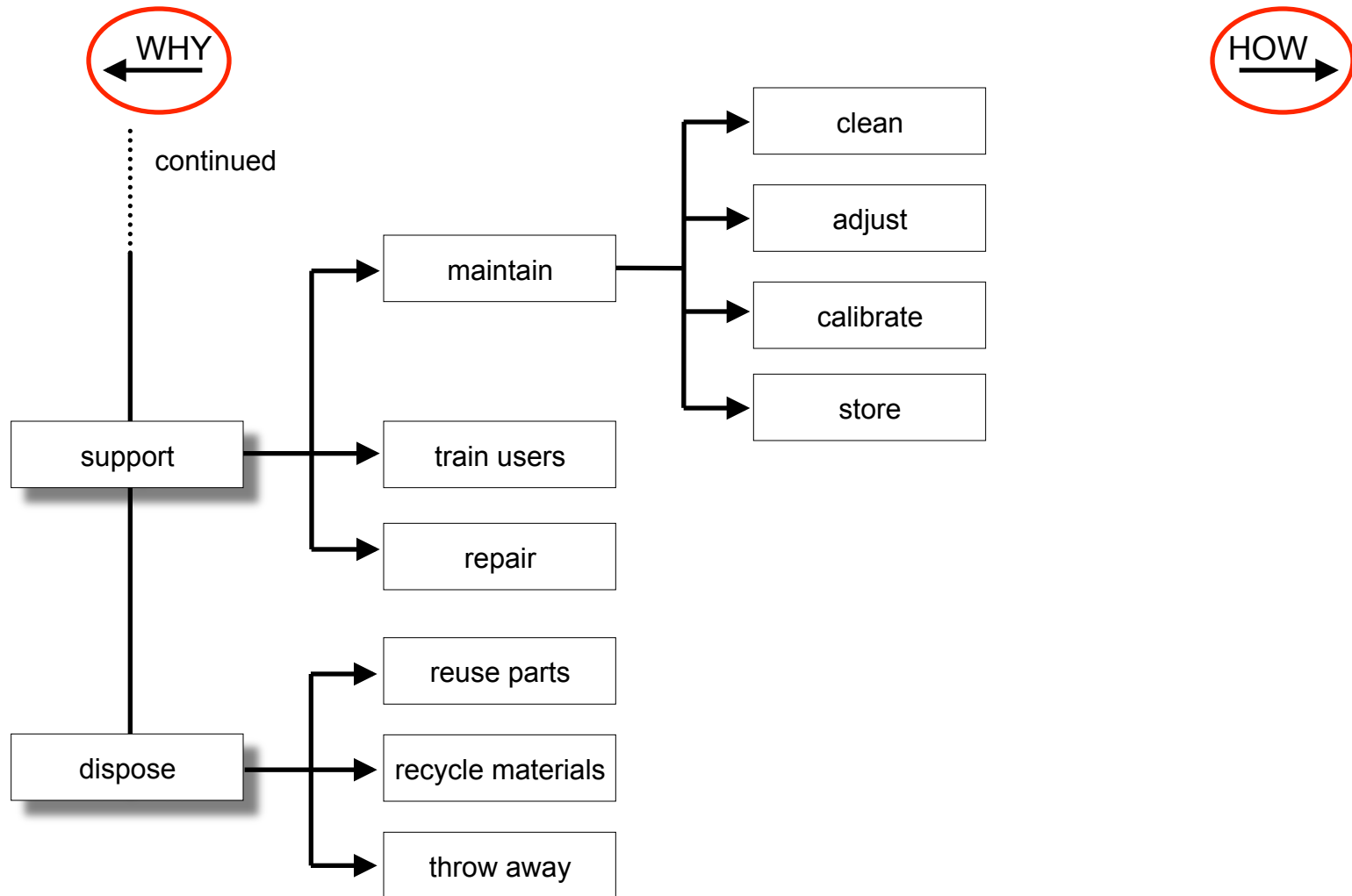
# LIFE CYCLE ANALYSIS



# LIFE CYCLE ANALYSIS



# LIFE CYCLE ANALYSIS



# GRASS CUTTER

*ideas for solutions* →

*functions* ↓

| Solution<br>Sub-func | 1                     | 2                   | 3                     | 4             |
|----------------------|-----------------------|---------------------|-----------------------|---------------|
| Supply energy        | Human                 | Electric mains      | Electric battery      | Petrol        |
| Cut grass            | Horizontal axis blade | Vertical axis blade | Parallel motion blade | Rotating wire |
| Convey cuttings      | Kinetic energy        | Air pressure        | Gravity               |               |
| Store cuttings       | Box                   | Bag                 | None                  |               |

→

↓

Combination 1      Combination 2      *meet demands*



# ASTHMATIC INHALER

| Solution<br>Sub-func | 1                | 2                | 3               | 4               |
|----------------------|------------------|------------------|-----------------|-----------------|
| Make drug            | Mixing           | Synthesis        |                 |                 |
| Meter drug           | Volume of liquid | Weight of liquid | Volume of solid | Weight of solid |
| Store drug           | Bulk liquid      | Metered liquid   | Bulk solid      | Metered solid   |
| Load drug            | Factory          | Patient          |                 |                 |

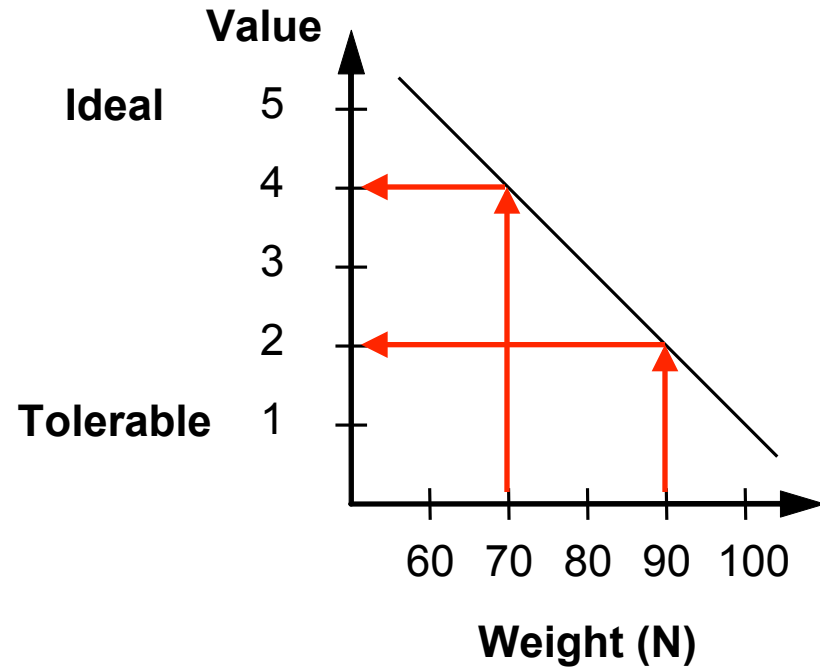
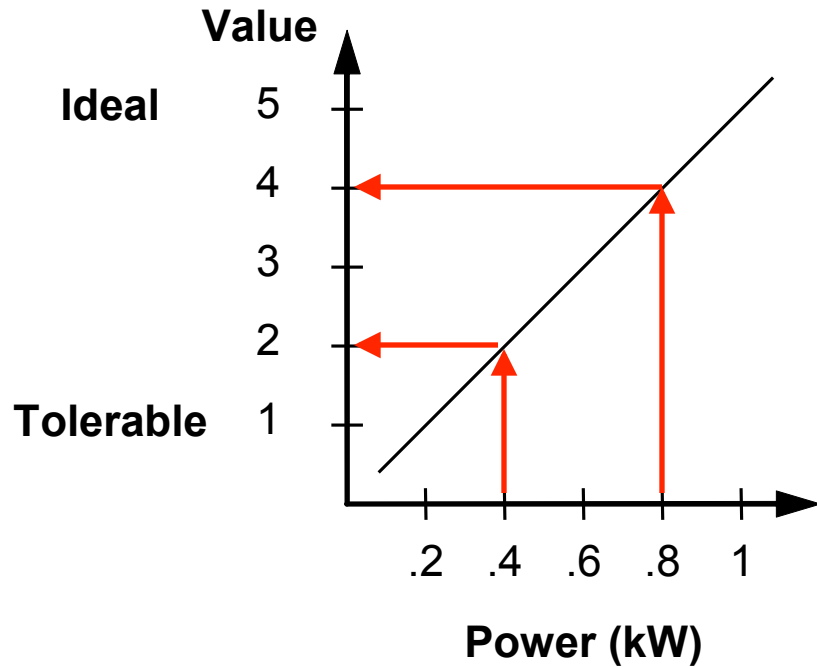


Combination 1

Combination 2

*select only  
combinations which  
meet the demands*

# GRASS CUTTER



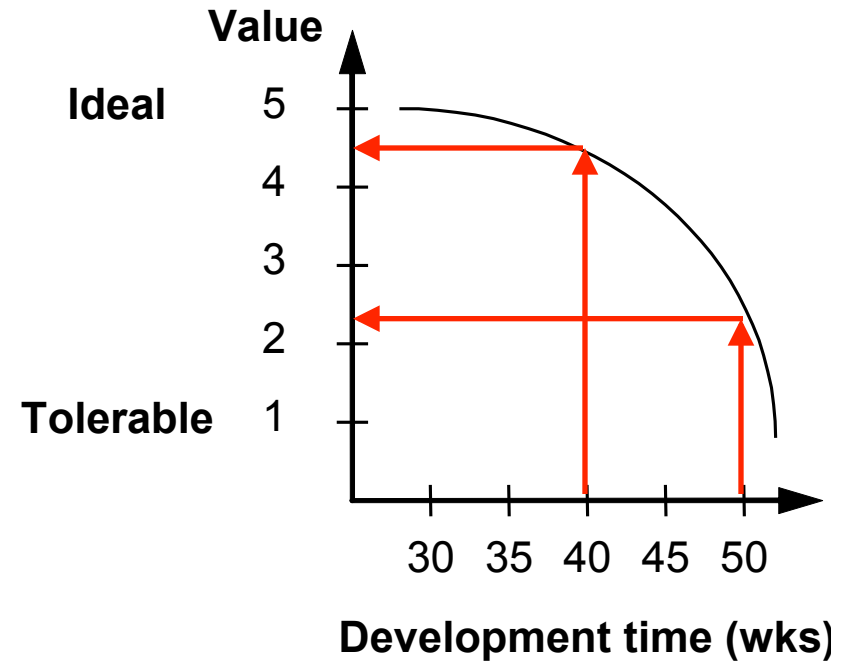
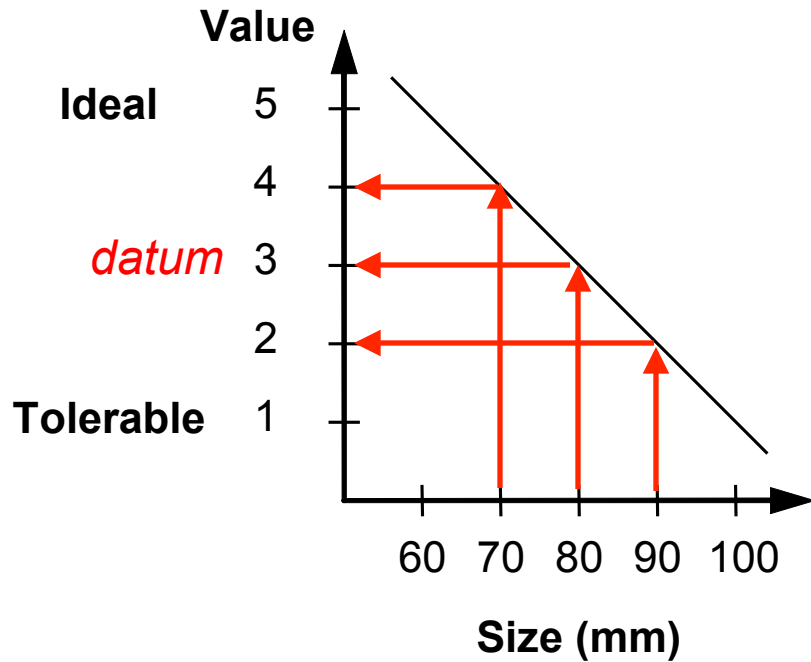
*estimates of parameters associated  
with concepts – may require some  
embodiment design*

# GRASS CUTTER

|                   |           | Concept 1 |        | Concept 2 |        | Ideal  |
|-------------------|-----------|-----------|--------|-----------|--------|--------|
| Criteria          | Weighting | Value     | Wt val | Value     | Wt val | Wt val |
| Weight            | 3 X       | 2 =       | 6      | 4         | 12     | 15     |
| Appearance        | 3         | 2         | 6      | 4         | 12     | 15     |
| Power             | 2         | 2         | 4      | 4         | 8      | 10     |
| Height adjustment | 2         | 4         | 8      | 2         | 4      | 10     |
| Cutting speed     | 1         | 3         | 3      | 5         | 5      | 5      |
| Life              | 1         | 4         | 4      | 2         | 2      | 5      |
|                   |           | 31        |        | 43        |        | 60     |

maximum

# ASTHMATIC INHALER



# ASTHMATIC INHALER

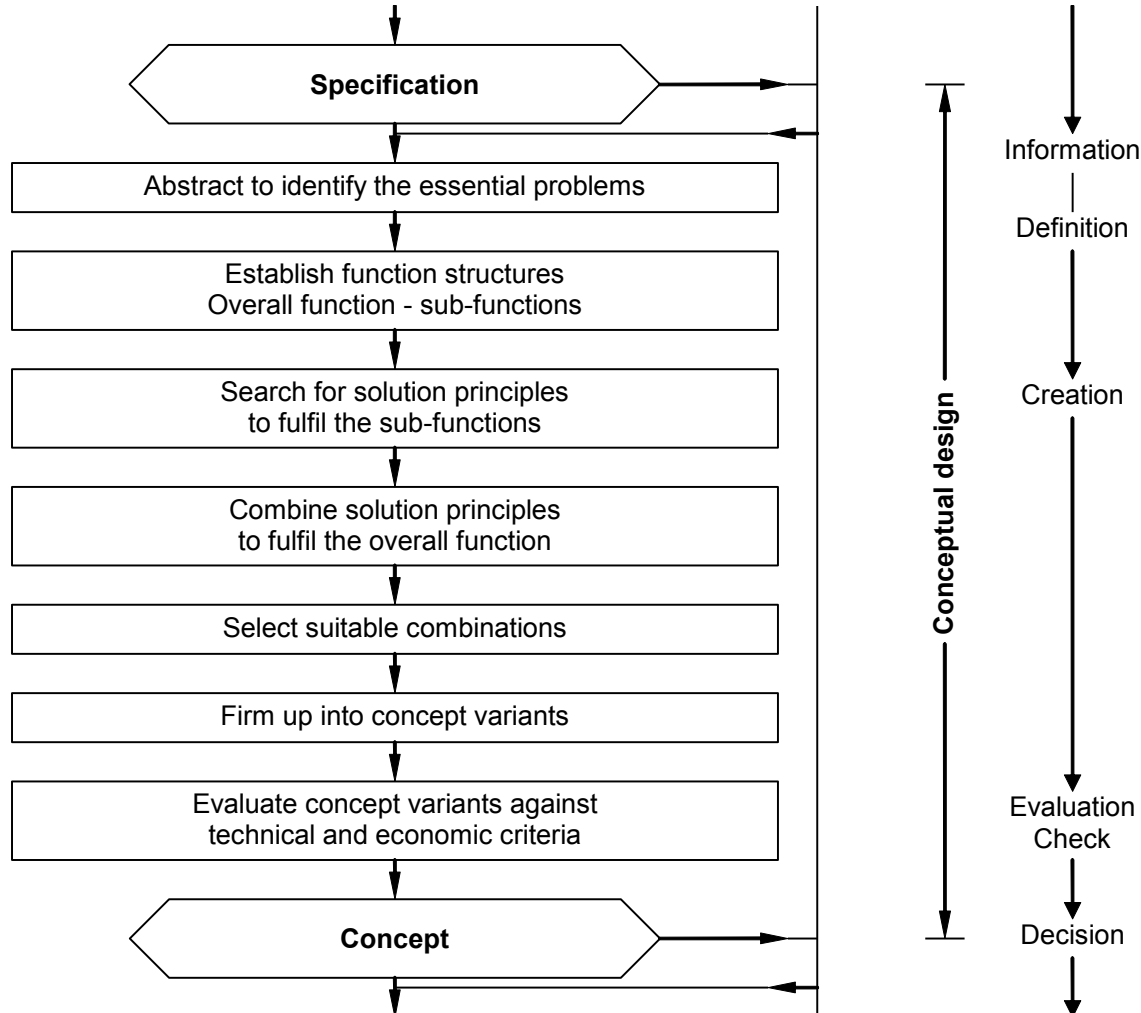
|                  |           | Concept 1 |        | Concept 2 |        | Concept 3 |        |
|------------------|-----------|-----------|--------|-----------|--------|-----------|--------|
| Criteria         | Weighting | Value     | Wt val | Value     | Wt val | Value     | Wt val |
| Ease of use      | 5 X       | DATUM     |        | +1 = +5   |        | +2        | +10    |
| Size             | 2         |           |        | -1        | -2     | -1        | -2     |
| Development time | 2         |           |        | -1        | -2     | -1        | -2     |
| Unit cost        | 1         |           |        | -1        | -1     | -2        | -2     |
| Appearance       | 1         |           |        | +1        | +1     | +2        | +2     |
| Refillable       | 1         |           |        | 0         | 0      | 0         | 0      |
|                  |           |           | 0      |           | +1     |           | +6     |

*guidance only + record of discussions*

*sensitivity to criteria weightings?*

# SUMMARY

The conceptual design stage has been summarised by Pahl and Beitz.



# SUMMARY

The process of concept generation and evaluation is a vital part of the design process and can have a significant impact on the success of the project. It is important to explore the widest range of possible solutions before selecting that which best matches the specification.

