Agenda:

1. HW #5 (due on Thursday)

2. Product Conceptual Design Process
   - Function Structure (FS)
     - not to be confused with the FAST diagram
   
   - Morphological matrix
     - FORM

   - Concept selection
HW #5

Language:

Function

WHY? purpose

provide power → car engine
(car)

process documents → Word processor

function is useful in determining customer needs

(form is useful for determining technical metrics)

(SUBJECTIVE)

(OBJECTIVE)
function

provide power

Customer needs

(1) high performance

(2) high fuel economy

form

car engine

technical metrics

Acceleration (m/s²)

(0-60 mph in X secs)

Miles per gallon

Read the chapters on

1. Identifying Customer Needs  

2. Product Specifications (PS)

HW #5, Problem 1

- Read chapter on PS in the text
- Lessons learned?
- How do you use the HOQ for the bicycle suspension fork?
HW # 5

Problem #2: Creating a HOQ

for 2 products (from the list)

1. Create a process for creating HOQ

   This process would combine
   - Product Dissection (FAST) → Lecture #10, 11
   - HOQ process → Lecture #9

Example Word

   Main function → Process documents

   Sub-functions

   "Sub-systems" and "components"

   - Open documents
   - Manipulate documents
   - Save documents

   do this dissection while using/playing
   with the product (MS Word)
for MS Word

example of

Customer Need → Technical metric (during testing)
reliable (does not "crash") → "bug" count

"bugs/week"

Target specification:

(Release product when)
bugs/wk = some specified # (say 5)

# of bugs ~ ~ ~ ~ ~ ~

↑

# of features

↑

Time
HW #3, Prob 3: HOQ for your intended new products

- Identify related products
- Reverse Engineer (Dissect) these products using FAST
- Create the HOQ for the new product

- Do team problem-solving
- Every member of the team must submit this (team) HOQ
Conceptual Design of New Products

Statement of the problem:

1. Generate several alternative concepts to realize a high-level idea for a new product.

   High-level idea: device for saving energy in the home

   : autonomous system (robot) capable of operating indoors (e.g. in a house)

2. Compare and assess these concepts relative to each other.

3. Select one (or two) feasible concepts (designs) for further development

Basic ideas

(1) In order to develop several alternative concepts, it is crucial to separate FUNCTION (WHY) from FORM (HOW).
⇒ Create an abstract functional representation of the product, called the FUNCTION STRUCTURE (FS).

(II) No product is completely new
⇒ find existing products related to the intended new product,
and reverse engineer these products.

The process for Product Conceptual Design

Step 1: Establish customer need: & technical metrics/specifications for the new product using the HOR

Step 2: Identify the main or primary function of the product (i.e., the product INTENT.)
Step 3: Identify one or more related products and then reverse engineer (dissect) these products using FAST

(Step 3 could precede Step 1)

[Note: Steps 1, 2, 3, are done in parallel or concurrently]

(See HW #5, Prob. 3)

Step 4: Create an abstract functional representation of the new (intended) product, called the Function Structure (FS)

Example: autonomous indoor device

Main function → perform useful tasks indoor

Sub-function 1

Sub-function 2

SF 3

Sub-function n

Provide power

Transmit power

Move

Sense location
(See Chapter on Concept
Generation in O&E, PD&D text.
also FS handout on class website)

Step 5 (i) for each sub-function,
generate alternative solution
principles for realizing that
subfunction

(ii) Organize the solution
principles (SPs) in a
morphological matrix (MM)

[Zwicky]
Morphological matrix (MM) for the autonomous indoor device
(from research, creativity [brainstorming...], etc.)

Solution
Principles

Sub-functions

Solution Principle 1 SP2 SP3 ...

(SP1)

SF1 Electrical Gasoline Solar Wind ...

(Provide power)

SF2 Gearbox Hydraulic Pneumatic (air)

(transmit power)

SF3 wheels legs air-cushion

(move w.r.t. ground)

SF4 Vision Solar ...

(sense)

all other
subfunctions

① ② ③

Step 6: Generate 6-10 alternative concepts, by suitably combining the solution principles in the MM.

(See above: "Zig-zagging" through the MM in a rational manner)
Note: The first few columns of the morphological matrix would typically contain the results of dissecting related products (e.g., in this example products like the ROOMBA).

Step 7: Identify an appropriate set of selection criteria to assess/compare these alternatives, and use these selection criteria to construct a utility function (UF). UF will be used to compare & select from the alternatives.

Step 8: Use the utility function (Step 7) to compare the alternatives generated in Step 6; and, then, select 1 (or 2) feasible concepts for further development (prototyping, etc.).

Useful references: The text U&E, PD&D

Chapter on "Concept Generation" (4th Ed., Chap. 6)
Chapter on "Concept Selection" (4th Ed., Chap. 7)